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NATIONAL DAM INSPECTION PROGRAM. LACKAWANNA DAM (NDS-ID-PA-0091--ETC(U)
SEP 78 DACW31-78-C-0046

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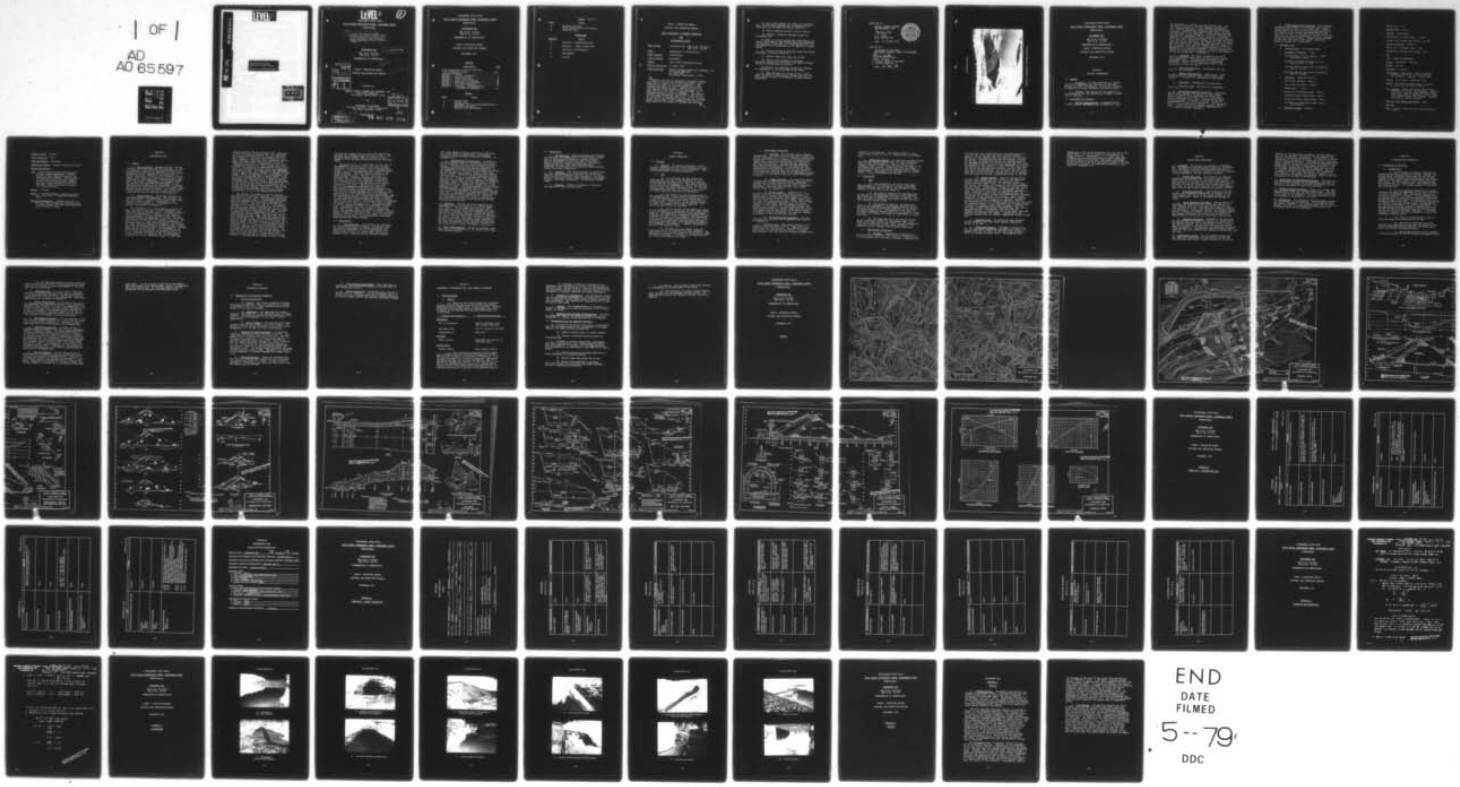

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LEVEL II

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program. Lackawanna Dam (NDS-ID-PA-00913, DER-ID-35-139), Susquehanna River Basin, South Branch Tunkhannock Creek, Lackawanna County, Pennsylvania. Phase I Inspection Report.

LACKAWANNA DAM

(15) DACW31-78-C-0046

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

(11) Sep 78

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

(12) 78p.

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

411 004

SEPTEMBER 1978

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SEPTEMBER 1978

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Lackawanna Dam (NDS ID No. PA-00913; DER ID No. 35-139)
Owner:	Commonwealth of Pennsylvania
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	South Branch Tunkhannock Creek
Date of Inspection:	15 August 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on the visual inspection, available records, calculations and past operational performance, Lackawanna Dam is judged to be in good condition. The spillway will pass the Probable Maximum Flood (PMF) without overtopping the dam. Based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as adequate. The existing spillway can accommodate a flood with a peak inflow of 117 percent of the PMF peak flow. If the low area of the top of the embankment were brought up to design grade, the spillway could accommodate a flood with a peak inflow of 121 percent of the PMF peak inflow.

In view of the concern for safety of Lackawanna Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Repair leaking joints in outlet conduit.

(2) Develop a detailed warning system for Lackawanna Dam.

In order to correct operational, maintenance and repair deficiencies, and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Replace riprap on upstream slope and restore embankment to design elevation.

(2) Monitor damp area along toe of dam.

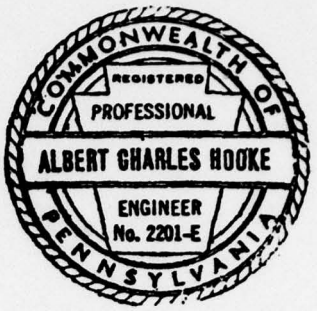
(3) Monitor rock surfaces in spillway chute for erosion of such extent that might endanger the dam or appurtenant structures.

In addition, the following operational measure is recommended to be undertaken by the Owner:

(1) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency warning system procedures.

Submitted by :

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.



A. C. HOOKE
Head, Dam Section

Date: 26 October 1978

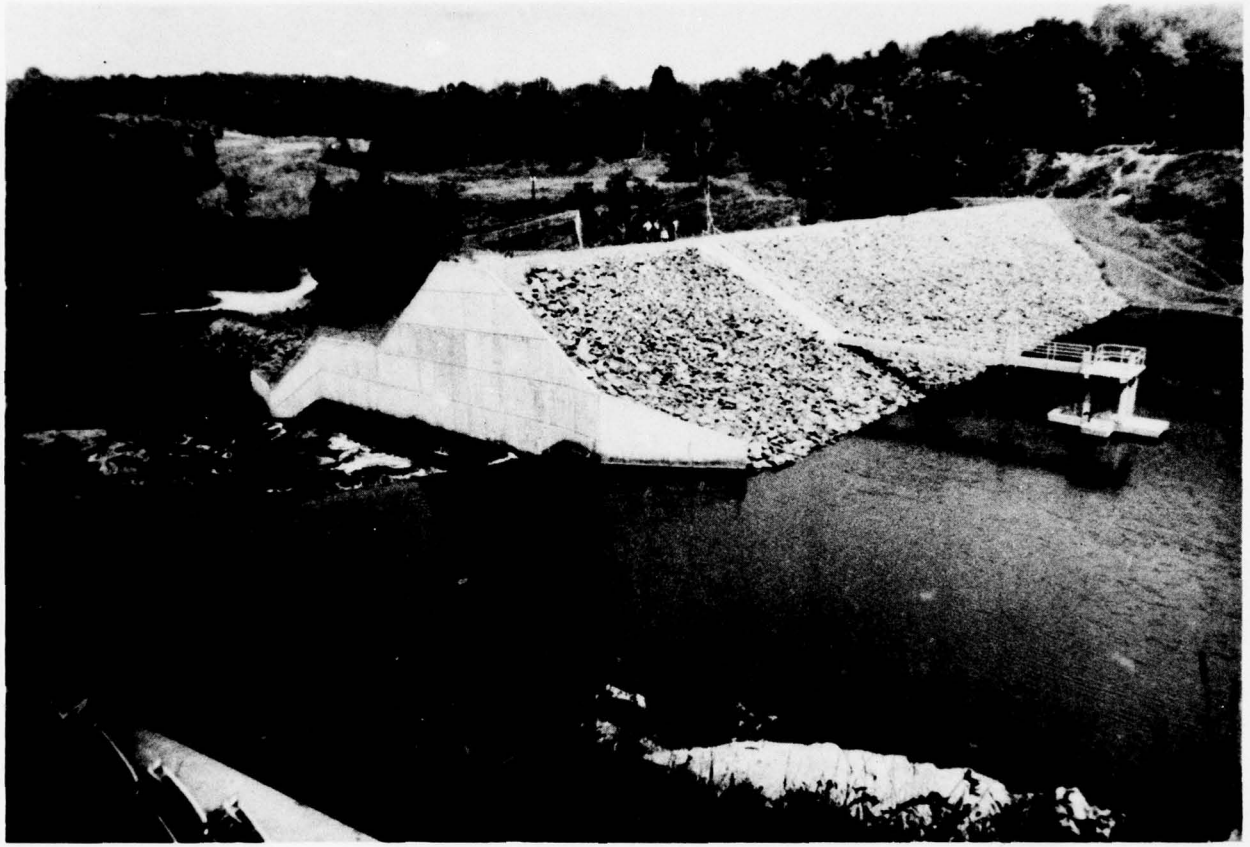
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

C. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 12 Dec 78

LACKAWANNA DAM



Spillway, Embankment, and Intake Structure.

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SEPTEMBER 1978

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lackawanna Dam is a zoned rockfill embankment with an impervious core.

The embankment is 350 feet long and 69 feet high. The spillway is located at the left abutment and consists of a concrete ogee weir, a chute section excavated into rock, and a stilling basin excavated into rock. A three line grout curtain 55 feet deep is under the spillway and the left half of the embankment. A concrete training wall separates the embankment from the spillway. The outlet works is located near the center of the valley and consists of a drop inlet, a horseshoe conduit 6 feet high and 6 feet wide, and a stilling basin. The intake structure is equipped with stoplogs for controlling the reservoir level, a 6-foot by 6-foot slide gate for drawing down the reservoir, and an 18-inch gate valve on a bypass conduit for low flow augmentation or reservoir drawdown. Various features of the project are shown on the Plates at the end of this Report and on the Photographs in Appendix D.

b. Location. The dam is located on the South Branch Tunkhannock Creek about 10 miles north of Scranton, Pennsylvania. Lackawanna Dam is shown on USGS Quadrangle, Dalton, Pennsylvania, with coordinates N41°33'20" - W75°43'10" in Lackawanna County. The location map is shown on Plate 1.

c. Size Classification. Intermediate (69 feet high, 14,200 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Lackawanna Dam (Paragraph 5.1e.).

e. Ownership. Commonwealth of Pennsylvania.

f. Purpose of Dam. Recreation at Lackawanna State Park.

g. Design and Construction History. Lackawanna Dam was built between 1969 and 1971 by the Commonwealth of Pennsylvania, Department of Forests and Waters, Bureau of State Parks as part of the development of Lackawanna State Park. The dam was designed by the Department of Forests and Waters, Bureau of Engineering, Division of Flood Control. The Contractor was B. G. Coon Construction Company, Luzerne, Pennsylvania. Construction of the dam was supervised by O. L. Cummins, Resident Engineer.

h. Normal Operational Procedure. The reservoir is normally maintained at the spillway crest level by having stoplogs in place at the drop inlet. Excess inflow passes over the concrete spillway ogee and into the natural stream channel downstream from the dam. The 6-foot by 6-foot slide gate at the base of the intake structure and the 18-inch gate valve on the bypass conduit are normally closed. However, during periods of low flow, the valve on the bypass conduit is opened to augment flow downstream.

1.3 Pertinent Data.

a. Drainage Area. 44.9 Square Miles.

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite - 3,000 (September, 1975).

Emergency drawdown line with pool at Elevation 992.0 - 900.

Spillway capacity with pool at Elevation 1022.2 - 54,000.

Spillway capacity with pool at Elevation 1023.0 - 56,000.

c. Elevation. (Feet above msl.)

Top of dam (design) - 1023.0.

Top of dam (low spot) - 1022.2.

Maximum pool - 1022.2.

Normal pool (spillway crest) - 992.0.

Upstream invert outlet works - 955.0.

Downstream invert outlet works - 951.7.

Streambed at centerline of dam - 954.0 (approximate).

d. Reservoir Length. (Miles.)

Normal pool - 2.27.

Maximum pool - 2.90.

e. Storage. (Acre-feet.)

Normal pool (spillway crest) - 2,400.

Maximum pool (design top of dam) - 14,200.

f. Reservoir Surface. (Acres.)

Normal pool (spillway crest) - 202.

Maximum pool (design top of dam) - 549.

g. Dam.

Type - Rockfill embankment.

Length - Embankment - 360 feet.

Height - 69 feet.

Top Width - 20 feet.

Side Slopes - Downstream - 1V on 1.5H above Elevation 999.0; 1V on 2.5H below Elevation 996.0. Upstream - 1V on 2.0H.

Zoning - Seven zones. Impervious core.

Cutoff - Earthfilled cutoff trench. Extends to rock over left half of valley.

Grout Curtain - Three line grout curtain under spillway and left hf of embankment. Grouted using split spacing, stage grouting method with three zones to depth of 55 feet. Holes are inclined toward left abutment. Primary holes are on 10-foot centers.

h. Diversion and Regulating Tunnels. None.

i. Spillway.

Type - Concrete ogee weir with chute excavated in rock.

Length of Weir - 80 feet.

Crest Elevation - 992.0.

Upstream Channel - Reservoir.

Downstream Channel - Channel excavated in rock.

j. Regulating Outlets.

Type - 6-foot wide by 6-foot high horseshoe conduit through embankment. Conduit has drop inlet intake structure at upstream end with stoplogs. Intake structure also has 6-foot by 6-foot opening at base and an 18-inch bypass conduit. Weirs at intake structure are at Elevation 986. Invert of intake structure is at Elevation 955.5.

Length - 370 feet.

Access - Horseshoe Conduit - downstream toe of dam. Drop Inlet - bridge from upstream slope.

Regulating Facilities - Aluminum stoplogs; 6-foot by 6-foot rising stem slide gate with 10:1 gear reducer; 18-inch rising stem gate valve on bypass conduit.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Engineering data that was available for review included the following: a study of alternate sites entited "Engineering Report on a Proposed State Park Dam and Reservoir on South Branch Tunkhannock Creek" prepared by the Department of Forests and Waters, Division of Flood Control, in December, 1964; results of laboratory analyses of soils performed by Larsen Engineers, Consulting Soils Engineers, Harrisburg, Pennsylvania, in December, 1966; the project plans and Special Requirements of the Specifications prepared by the Department of Forests and Waters, Division of Flood Control, in August 1968; and the permit application report. The project plans include hydraulic data for the spillway and outlet works and the logs of subsurface investigations.

b. Design Features. The primary features of Lackawanna Dam are the embankment, the spillway, and the outlet works. A general plan of the project features is shown on Plate 2. Photographs of the features are in Appendix D. A discussion of the geology is presented in Appendix E.

The embankment is a zoned rockfill structure 350 feet long and 69 feet high. Typical embankment sections are shown on Plates 3 and 4. As shown on Plate 3, part of the embankment is founded on rock and part is on overburden. A grout curtain extends under the embankment where the embankment is on rock. The grout curtain also extends under the spillway (Plate 3). The grout curtain is a three line curtain constructed by the split spacing, stage grouting method. The curtain has three zones and extends to a depth of about 55 feet. The holes are inclined toward the left abutment. Primary holes are on 10-foot centers. The embankment is 20 feet wide at the top and has an upstream slope of 1V on 2H. From the downstream toe of the dam, which is at Elevation 965, to Elevation 996, the downstream slope is 1V on 2.5H. There is a berm 37.5 feet wide

between Elevation 996 and Elevation 999. The slope is 1V on 1.5H above Elevation 999. The embankment has six pervious zones and an inclined impervious core (Plate 4). The zones upstream from the core are a compacted filter zone and a compacted rockfill zone. The zones downstream from the core are a compacted filter zone, a compacted rock spall zone, a compacted rockfill zone, and a dumped rock zone. From the left abutment to approximately Station 2+60, which is a distance of about 65 feet, the embankment is founded on rock. The remainder of the embankment, which is about 285 feet in length, is founded on overburden. Where the embankment is on overburden, the impervious core extends into a cutoff trench. There is a filter blanket between the foundation and the embankment fill (Plates 3 and 4). Both the upstream and downstream slopes have riprap from Elevation 1013 to the top of the dam, which is at Elevation 1023. A 15-inch diameter sanitary sewer gravity line passes through the right abutment (Plates 2, 3, and 7). It is encased in concrete and has 2 concrete seepage collars where it is in the impervious core zone.

The spillway is located at the left abutment and consists of a concrete ogee weir, a chute section excavated into rock, and a stilling basin excavated into rock (Plates 5 and 6). The spillway and embankment are separated by the spillway training wall (Plates 5 and 6). The left side of the spillway is bounded by the surface of a rock cut. The concrete weir has a crest length of 80 feet and is located at the upstream end of the training wall, which is about 40 feet upstream from the axis of the dam. The weir is keyed into rock. Downstream from the weir is a chute section 180 feet long. The upper part of the chute has an 8 percent slope, and the lower portion has a 38 percent slope. The chute transitions from a width of 80 feet at the weir to 60 feet wide at the break in slope. The lower portion of the chute has a constant width of 60 feet. A stilling basin, excavated into rock, is at the end of the chute (Plates 5 and 6). Concrete chute blocks and baffle blocks are keyed into the rock at the stilling basin. The training wall on the right side of the spillway consists of a liner wall near its base and a semi-gravity section resting on a thick concrete footing (Plate 6). The maximum wall height is about 41 feet.

The rock cut surface that is on the left side of the spillway has a maximum height of about 70 feet. The spillway outlet channel joins the natural stream channel a short distance downstream from the stilling basin.

The outlet works is located near the left end of the embankment and consists of a drop inlet intake structure, a horseshoe conduit, and a stilling basin (Plate 7). A concrete stairway and an aluminum bridge provide access to operating controls located at the intake structure. The drop inlet has weirs on two sides of the structure. The weir crests are at Elevation 986. Aluminum stoplogs are placed atop the weirs so that the pool elevation is controlled by the spillway crest. A slide gate, 6-feet by 6-feet, is located on the upstream side of the intake structure at its base. The purpose of the slide gate is for emergency drawdown of the reservoir. The approach leading to the slide gate consists of a small inlet structure equipped with a trashrack. Stop-log slots are located upstream from the slide gate so that repairs on the slide gate can be accomplished. An 18-inch diameter conduit, called the bypass conduit, has its inlet upstream from the slide gate and its outfall in the transition section between the intake structure and the horseshoe conduit. The bypass conduit is equipped with a gate valve and an air vent. The bypass conduit is used to augment streamflow or to drawdown the reservoir. The horseshoe conduit is 6 feet wide, 6 feet high, and 265 feet long. The conduit is founded on rock. Two seepage collars surround the conduit where it passes through the impervious core. A concrete stilling basin is located at the end of the conduit at the downstream toe of the dam. The stilling basin discharges into the spillway outlet channel.

2.2 Construction.

a. Data Available. Construction data available for review included the following: the project plans and Special Requirements of the Specifications prepared by the Department of Forests and Waters, Division of Flood Control, in August 1968; construction progress reports submitted by the Resident Engineer;

and a Dam Completion Report submitted by the Director of the Bureau of Engineering, Pennsylvania Department of Environmental Resources (PennDER), in December 1971.

b. Construction Considerations. According to the Dam Completion Report, the project was constructed in accordance with the project plans and specifications. The specifications for the work were the "Standard Specifications and General Conditions" of the Commonwealth of Pennsylvania, Department of Forests and Waters, Division of Flood Control, dated 1963, and the "Special Requirements" added to the standard specifications. As far as can be determined, the project was constructed in accordance with good engineering practice. Progress reports filed by the Resident Engineer indicate that the field densities of compacted materials, where specified, were 100 percent of the prescribed density. Apparently, however, the borrow material was found to be unsatisfactory for the original embankment design. Information on file indicates that the dam was redesigned in 1970 to accommodate the properties of the available borrow materials. However, there was no information available that described the nature or extent of the modifications. There was no information available for review to indicate that any other unusual problems were encountered during construction of the dam.

2.3 Operation. Detailed records of operation for Lackawanna Dam are available in the form of inspection reports. Formal inspections have been made twice each year by the Park Superintendent and once each year by PennDER, Division of Completed Projects. The only major problem that has occurred during the life of the dam has been erosion of rock in the spillway chute. The June 1972 flood, which was caused by Tropical Storm Agnes, apparently caused substantial erosion along the base of the spillway training wall. The Corps of Engineers placed backfill concrete over the eroded areas to ensure the safety of the wall.

2.4 Other Investigations. As far as is known, there have been no investigations of the project other than those described herein.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Owner, the Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Water Quality Management, Division of Dams and Encroachments, and by the Bureau of Operations, Division of Completed Projects. The Owner made available personnel for information and operating demonstrations during the visual inspections.

b. Adequacy. The type and amount of design data and other engineering data available for review are limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of this project indicated that the project features have been properly maintained and are in good condition. Specific observations are described herein.

b. Dam.

(1) A survey made for this inspection indicated that the top of the embankment is at or above design grade except for a small area adjacent to the spillway (Photograph D). The design elevation for the top of the embankment is 1023.0, and the elevation of the low area is Elevation 1022.2. The Park Superintendent said that the low area is the result of vandals removing stone from the embankment.

(2) The rockfill on the upstream slope of the embankment was in good condition except at the top of the dam adjacent to the spillway (Photographs A, B, and F), where vandals have thrown stones into the spillway chute. The rockfill on the upstream slope is sound, well-graded red and gray sandstone. It varies in size from 6 to 24 inches.

(3) The top 10 feet of the downstream slope of the embankment is covered with 24-inch riprap (Photograph E). The remaining portions of the downstream slope are the surfaces of a compacted rockfill zone and a dumped rock zone. These portions of the downstream slope are covered with a much smaller rock that is not as resistant to weathering, and the result has been a growth of weeds over most of the downstream surface of the embankment (Photograph E). However, there was no growth of any brush or trees.

(4) One damp area was located along the downstream toe of the dam near the right abutment. The vegetation at this area was lush, but there was no standing water or seepage. The ground at the damp area was not softer than adjacent dry areas.

c. Appurtenant Structures.

(1) Spillway. The spillway had no apparent deficiencies. All concrete structures were in good condition (Photographs C, G, and J). Backfill concrete that was placed by the Corps of Engineers to repair erosion damage that occurred during the June 1972 flood was also in good condition. The exposed rock surfaces in the chute section were irregular and some fractures were visible (Photograph H). It was noted that the combination of the location of the weir and the height of the spillway training wall will probably produce flow across the upstream slope of the embankment parallel to the axis of the dam at high pool levels (Photographs C and F).

(2) Intake Structure. The drop inlet intake structure had no apparent deficiencies (Photograph L). Concrete was in good condition, all metalwork was painted, and the slide gate and gate valve stems were lubricated. The slide gate and gate valve opened easily during the inspection.

(3) Outlet Conduit. Inspection of the horseshoe conduit revealed four leaking joints. The fourth, sixth, seventh, and eighth joints from the downstream end of the conduit were leaking on the left side in the bottom 2 feet of the conduit. Each leak was less than 1 gallon per minute. There were no signs of piping of embankment materials into the outlet conduit. A very strong odor of hydrogen sulfide was present in the conduit. The Park Superintendent said that the odor occurs for several weeks each year in the late summer when the gate valve on the bypass conduit is opened to augment streamflow. No signs of sulfuric acid attack of the concrete were visible.

(4) Outlet Works Stilling Basin. The outlet works stilling basin had no apparent deficiencies (Photograph M).

d. Reservoir Area. The slopes adjacent to the reservoir vary from steep to mild. Some slopes are wooded and some are open land. No evidence of creep, rock slides, or land slides was visible. The Park Superintendent said that there is no known sedimentation

problem in the reservoir. The Owner controls a relatively small amount of the 44.9 square miles of drainage area.

e. Downstream Channel. An iron truss bridge crosses the spillway outlet channel about 200 feet downstream from the dam (Photograph K). The low steel of the bridge is about 1.5 feet above the top of the bank of the spillway outlet channel. Downstream from the bridge, the stream follows a relatively straight course through wooded areas. The community of Factoryville is located about 4.5 miles downstream from the dam.

3.2 Evaluation.

a. Dam.

(1) The low area on the top of the embankment adjacent to the spillway is 0.8 foot lower than design elevation, and it reduces the maximum spillway capacity to less than design capacity.

(2) The loss of stone on the upstream slope at the top of the embankment adjacent to the spillway has caused the aforementioned low area to develop. Unless the stone is replaced, the limits of the low area will probably become larger.

(3) The growth of weeds on the downstream slope of the embankment is unavoidable because the surface of the rockfill zones has weathered to the extent of almost being a soil. Maintenance of the slope is considered adequate because there was no growth of brush or trees, and because the weeds are reportedly cut twice each year.

(4) The damp area along the toe of the dam is not of serious concern at the present time. The cause of the damp area is not known. It was reported on a previous inspection in 1976, and, apparently, its character has not changed substantially since then.

b. Appurtenant Structures.

(1) Spillway. Examination of previous inspection reports indicates that erosion of exposed rock in the spillway chute has been a problem. Inspection of

the chute for this study indicates that additional erosion of rock in the spillway will probably continue. However, at the present time, the condition of the spillway chute is satisfactory and does not present a hazard to the dam. Although flow across the upstream slope of the embankment parallel to the axis of the dam will occur at high pool levels, erosion of the embankment is unlikely. The surface of the rockfill is about 1.5 feet lower than the top of the spillway training wall; and this will reduce the erosion potential. It is likely that the chain-link fence on the spillway training wall will be damaged, but this would not present significant hazard to the dam.

(2) Outlet Conduit. The four leaking joints in the outlet conduit are all located in the compacted rockfill zone downstream from the impervious core, filter, and rock spall zones. In the reach where leakage exists, the conduit is founded on rock and surrounded by rock spalls. Consequently, leakage at the four joints does not cause serious concern at the present time because the potential for piping of embankment materials is small. Although a strong odor of hydrogen sulfide was present in the conduit, nothing was observed that indicated any attack of the concrete has occurred. Under certain conditions, hydrogen sulfide can be oxidized to produce sulfuric acid, which is harmful to concrete. However, the concentration of the hydrogen sulfide that can react with the concrete conduit is not considered to be strong enough to affect the concrete since Type II cement, which is resistant to moderate sulfate concentrations, was used in the construction. Furthermore, the fact that the hydrogen sulfide is present for only a few weeks each year reduces the potential for damage. Consequently, the hydrogen sulfide does not present significant hazard to the dam.

d. Reservoir Area. No conditions were observed in the reservoir area that might present significant hazard to the dam.

e. Downstream Channel. Although no rating curve for the downstream channel was available for review, it appears that the low steel of the iron truss bridge is above the design tailwater level. The drawings show

dumped rock to be placed downstream from the dam to Elevation 965.0, and the low steel of the bridge is at Elevation 966.5. Furthermore, it is likely that the bridge would be washed away before causing significant tailwater effects on the dam. Therefore, the bridge is not believed to present significant hazard to the dam. Additional discussion of downstream conditions is presented in Paragraph 5.1e.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The project is operated in accordance with the Operation and Maintenance Manual for Lackawanna Dam. The manual provides detailed operating instructions for normal conditions, periods of low flow, periods of flood emergency, and for reservoir drawdown.

a. Normal Procedure. The reservoir is normally maintained at spillway crest level with excess inflow going over the weir and into the downstream channel. To keep the pool at spillway crest level, aluminum stoplogs are kept in place at the drop inlet intake structure. The 6-foot by 6-foot slide gate and the 18-inch diameter gate valve at the intake structure are normally closed.

b. Low Flow Procedure. When evaporation exceeds inflow, the streamflow is augmented by opening the 18-inch diameter gate valve on the bypass conduit at the intake structure. There is no prescribed minimum release.

c. Flood Emergency Procedure. During periods of flooding, the 6-foot by 6-foot slide gate and the 18-inch diameter gate valve are kept closed and the stoplogs are left in place. The spillway, therefore, passes all floodwaters. Continuous patrols are conducted during floods to check for seepage, erosion, and floating debris. Any unusual conditions are reported to the Office of Engineering and Construction, Harrisburg, Pennsylvania.

d. Drawdown Procedure. Drawdown of the reservoir for maintenance and inspection purposes is accomplished by removing stoplogs and/or by opening the gate valve on the bypass conduit. Use of the 6-foot by 6-foot slide gate is reserved for drawing down the reservoir during extreme emergencies. The Operation and Maintenance Manual specifies that the drawdown rate should not exceed one inch per hour.

4.2 Maintenance of Dam. The Park Superintendent and his staff are responsible for maintenance of the dam. The Superintendent makes a formal inspection of all the

features of the dam every six months, and the report is sent to the Secretary, Department of Environmental Resources, Harrisburg, Pennsylvania. In addition, a formal inspection of the dam is also made each year by the Division of Completed Projects. The Operation and Maintenance Manual contains detailed instructions for inspection and maintenance of the dam and appurtenant structures. The three formal inspections of the dam each year, as well as informal inspections made more frequently, are used to evaluate the need for maintenance. The inspection performed for this study, and follow-up reports on file for previously recommended maintenance, indicate that the maintenance of the dam is satisfactory.

4.3 Maintenance of Operating Facilities. The inspection and maintenance program for the operating facilities is similar to the previously described program for the dam. The gates are opened at least once each year.

4.4 Warning Systems in Effect. There is no formal warning system in effect for the downstream areas. The Park Superintendent said that he would call local authorities in the event of an emergency. The Superintendent or the Park Foreman is available at all times.

4.5 Evaluation. The inspection and maintenance program for the project are satisfactory. The procedures used for normal, emergency, and drawdown operations are satisfactory. The lack of an emergency warning system for downstream areas is unsatisfactory.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic or hydraulic analyses for Lackawanna Dam were available for review. However, the project plans included hydraulic data for the dam consisting of the following: spillway rating curve, area-capacity curves, outlet works rating curves, and a drawdown curve. The data appeared to be satisfactory and was accepted for use in this study. The hydraulic data are shown on Plate 8. The design capacity of the spillway is 56,000 cfs.

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (intermediate) and hazard potential (high) classification of Lackawanna Dam is the Probably Maximum Flood (PMF). If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) The hydrologic analysis for this study was based on existing conditions of the Lackawanna Dam watershed, and the effects of future development of the watershed were not considered.

b. Experience Data. For this study, a PMF peak previously calculated for Stillwater Dam was transposed to the Lackawanna Dam watershed. The PMF peak flow was estimated to be 46,310 cfs at Lackawanna Dam. Hydrologic computations are included in Appendix C.

c. Visual Observations. A low area on the top of the embankment was revealed during the visual inspection. Adjacent to the spillway, the top of the embankment is at Elevation 1022.2, which is 0.8 foot lower than design elevation. Accordingly, the maximum spillway capacity is 54,000 cfs instead of the design capacity of 56,000 cfs. The existing spillway capacity, 54,000 cfs, was used in this study for the purpose of rating the spillway.

d. Overtopping Potential. For an occurrence of the PMF, the peak inflow of 46,310 cfs is less than the capacity of the spillway (Appendix C). Therefore, Lackawanna Dam will not be overtopped by the estimated PMF.

e. Downstream Conditions. As shown on Plate 1, Lackawanna Dam is located on the South Branch Tunkhannock Creek in Lackawanna County. The valley downstream from the dam is sparsely populated for the first 3.2 miles. In the next 1.1 miles of stream are occasional groups of low-lying structures that would be affected by a failure of Lackawanna Dam. At a distance of 4.3 miles downstream from the dam, the South Branch Tunkhannock Creek enters the corporate limits of Factoryville. The stream flows through the center of the community, and many houses are situated along its banks. Consequently, the downstream conditions indicate that a high hazard classification is warranted for Lackawanna Dam.

f. Spillway Adequacy. The existing spillway of Lackawanna Dam is capable of passing the PMF peak inflow of 46,310 cfs without overtopping the dam. Based on established OCE criteria as outlined in Paragraph 5.1 a.(2), the spillway capacity of Lackawanna Dam is rated as adequate. Neglecting the effects of surcharge storage, the spillway capacity of 54,000 cfs is 117 percent of the PMF

peak inflow. If the low area on the top of the embankment were brought up to design grade, which is a relatively minor maintenance task, the spillway capacity would be 56,000 cfs, or 121 percent of the PMF peak inflow.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Lackawanna Dam resulted in a number of observations relevant to structural stability. These observations are listed herein for the various features.

(2) Embankment. One damp area was located along the downstream toe of the embankment near the right abutment. The detailed description and evaluation of the damp area are in Paragraphs 3.1 b.(4) and 3.2 a.(4), respectively.

(3) Outlet Conduit. Four leaking joints were located along the left side of the outlet conduit. The detailed description and evaluation of the joints are in Paragraphs 3.1 c.(3) and 3.2 b.(2), respectively.

b. Design and Construction Data. No records of stability computations were available for review. The plans show the upstream slope to be 1V on 2H. The downstream slope is shown to be 1V on 2.5H from the toe of the dam to Elevation 996. A 37.5-foot wide berm is located between Elevations 996 and 999. Above Elevation 999, the downstream slope is shown on the plans as 1V on 1.5H. Surveys made for this inspection showed that the as-built slopes do not deviate significantly from the design slopes. The design slopes are within the range normally used for rockfill dams. Therefore, the stability of the embankment is probably adequate for design conditions.

c. Operating Records. There is no evidence that any stability problems have occurred for the dam during its operational history of 7 years. As far as can be determined, conditions at the site have been stable since the construction of the dam.

d. Post-Construction Changes. There have been no significant structural modifications of the dam since it was constructed in 1971.

e. Seismic Stability. Lackawanna Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Lackawanna Dam is judged to be in good condition. However, deficiencies of varying degree of importance were noted. A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Embankment:	
Top of embankment	Area at spillway lower than design elevation.
Upstream slope	Loss of riprap at spillway.
Downstream toe	Damp area.
Spillway:	
Chute section	Potential for erosion of fractured rock.
Outlet Works:	
Outlet conduit	Four leaking joints.

(2) The overtopping potential analysis shows that Lackawanna Dam will not be overtopped by the PMF. Based on OCE criteria, as outlined in Paragrah 5.1 a.(2), the spillway capacity is rated as adequate. Neglecting surcharge storage, the existing spillway can pass 117 percent of the PMF peak inflow. If the low area on the top of the embankment were brought up to design grade, which would be a relatively minor maintenance task, the spillway would pass 121 percent of the PMF peak inflow.

(3) Although no stability analyses for the embankment were available for review, the combination of exterior lines, design features, construction information, and performance history indicate that the stability of the embankment is probably adequate for design conditions.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented as soon as practical or in a timely manner, as noted.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for safety of Lackawanna Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Repair leaking joints in outlet conduit.

(2) Develop a detailed warning system for Lackawanna Dam.

b. In order to correct operational, maintenance and repair deficiencies, and to more accurately determine the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Replace riprap on upstream slope and restore embankment to design elevation.

(2) Monitor damp area along toe of dam.

(3) Monitor rock surfaces in spillway chute for erosion of such extent that might endanger the dam or appurtenant structures.

c. In addition, the following operational measure is recommended to be undertaken by the Owner:

(1) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency warning system procedures.

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

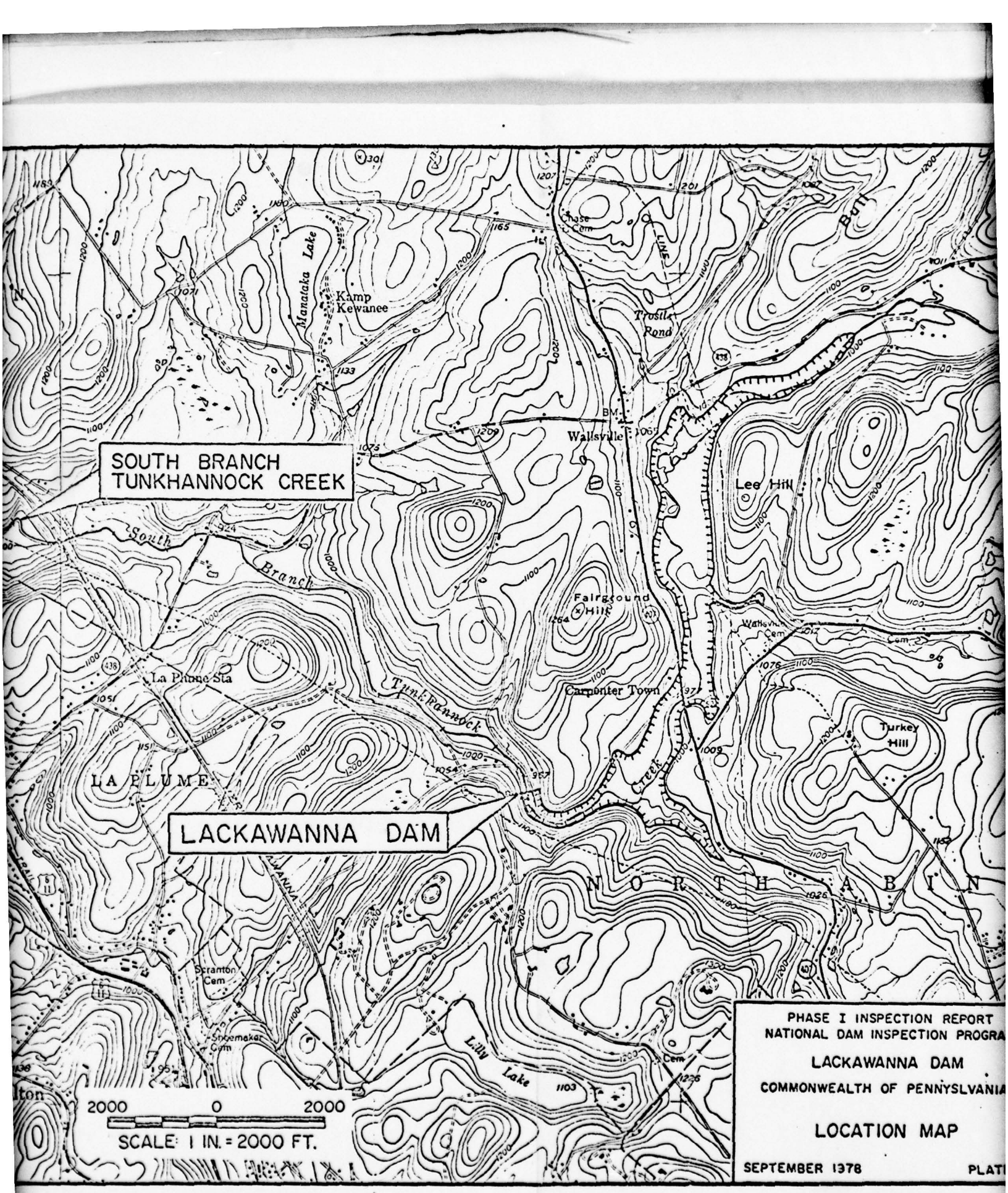
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SEPTEMBER 1978

PLATES

FACTORYVILLE
Factoryville
Sta
WYOMING CO
LACKAWANNA CO
B E N T O N
ERIE LACKAWANNA
BM 1042
Wright
Hill
Lake
Strip
Trailer
Park
LACKAWANNA
KEYSTONE COLLEGE
Creek
RAILROAD
La Plume
Glen Scho
Tunkhannock
VALLEY
PIPELINE
Sweeny Pond
Dalton
Wells Corners



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRA

LACKAWANNA DAM

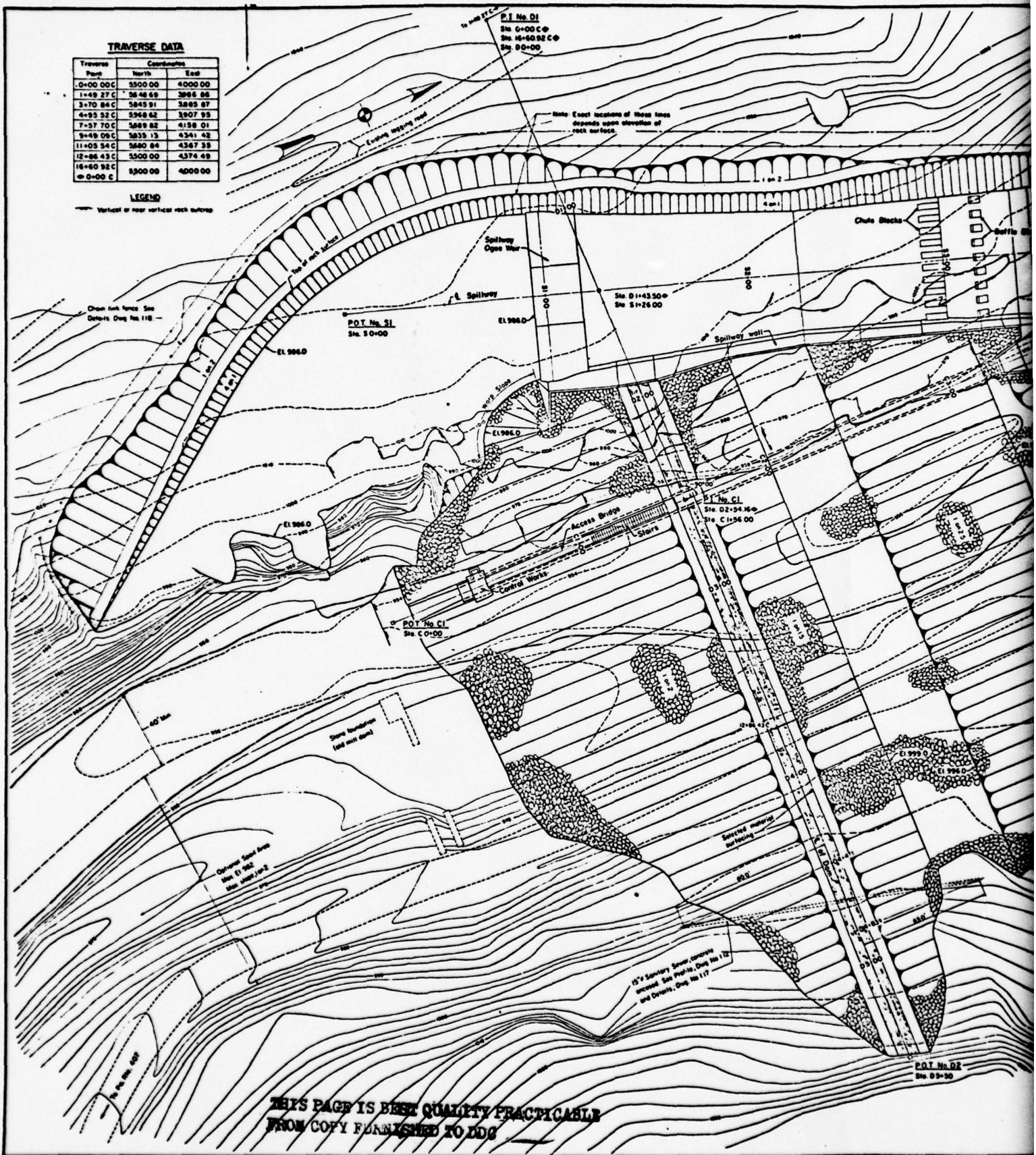
COMMONWEALTH OF PENNYSLVANIA

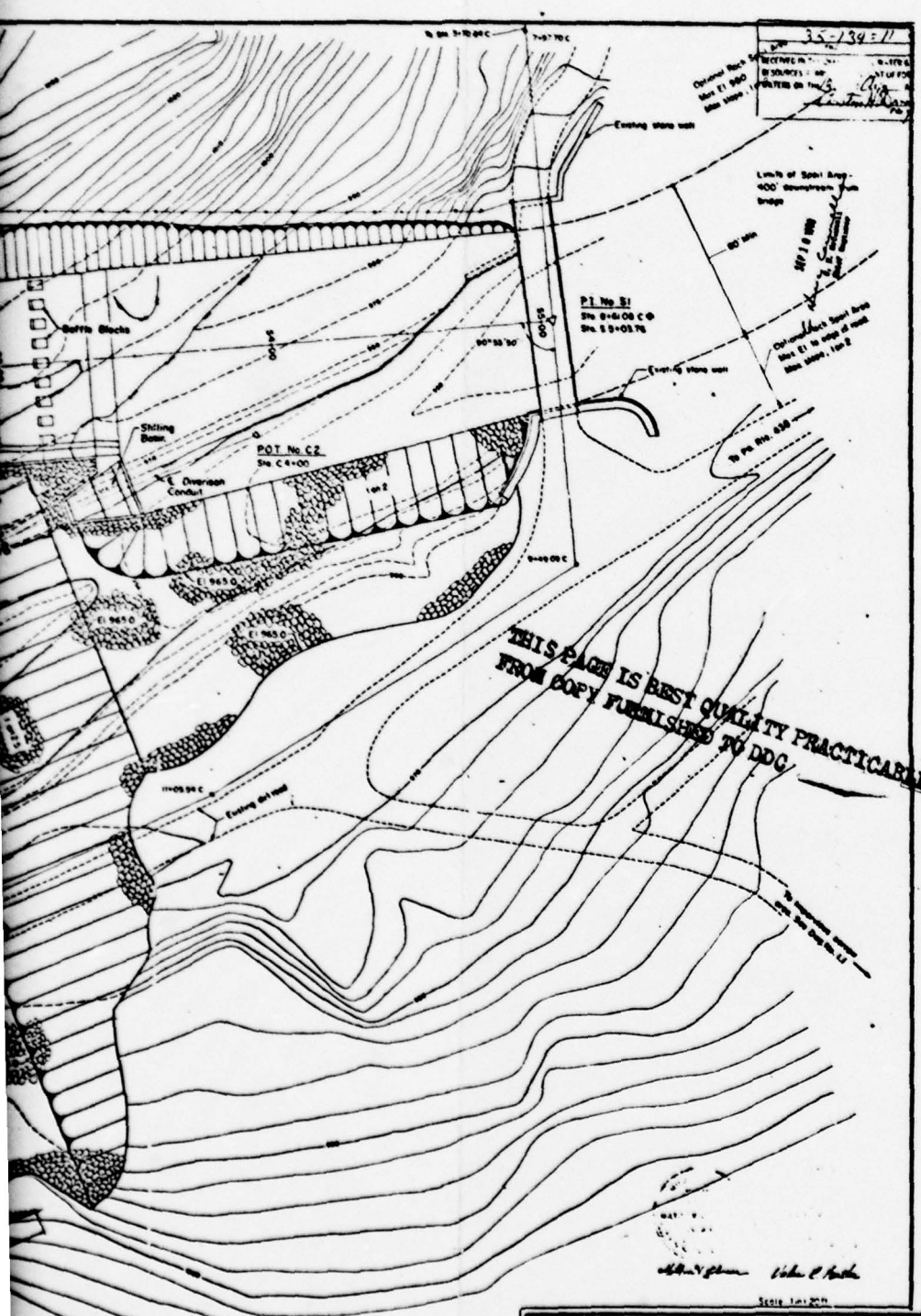
LOCATION MAP

SEPTEMBER 1378 PLAT

REPORT
PROGRAM
M
SLVANIA
P
PLATE 1

1 3





REFERENCES:

1. Excavation - Plan	Dwg No 110
2. Embankment - Profiles, Typical Section and Grouting Details	Dwg No 112
3. Embankment - Cross Sections	Dwg No 113
4. Spillway - Plan and Profile	Dwg No 114
5. Spillway - Cross Sections	Dwg No 115
6. Diversion Conduit - Profile, Cross Section and Details	Dwg No 117

NO.	DATE	REVISION	BY	CHKD.	APPD.

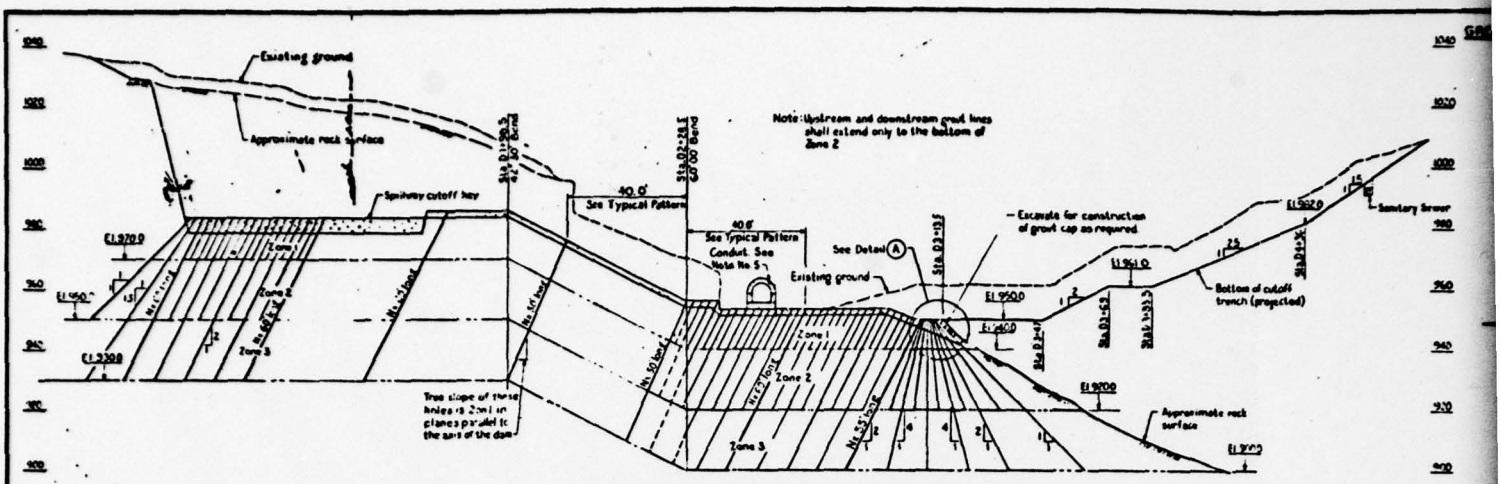
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LACKAWANNA DAM

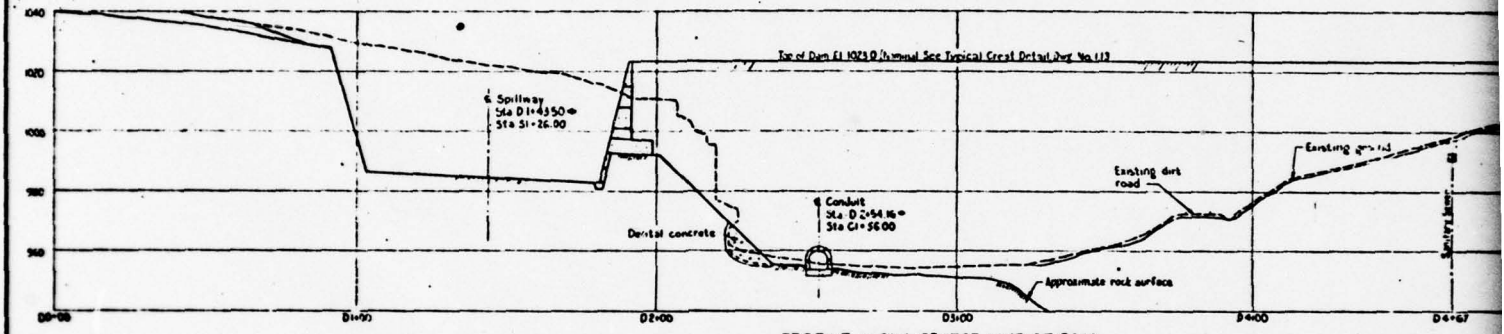
COMMONWEALTH OF PENNYSLVANIA

GENERAL PLAN

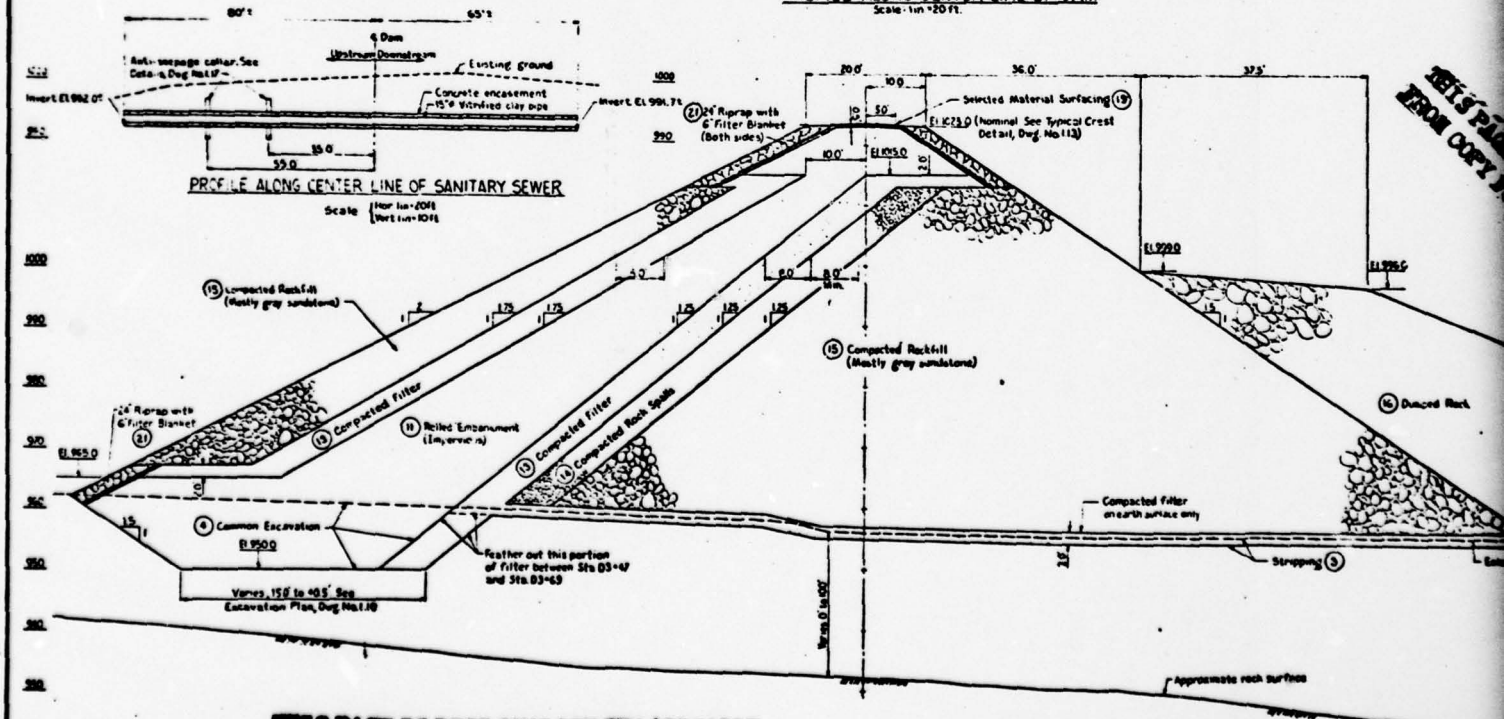
SEPTEMBER 1978 PLATE 2



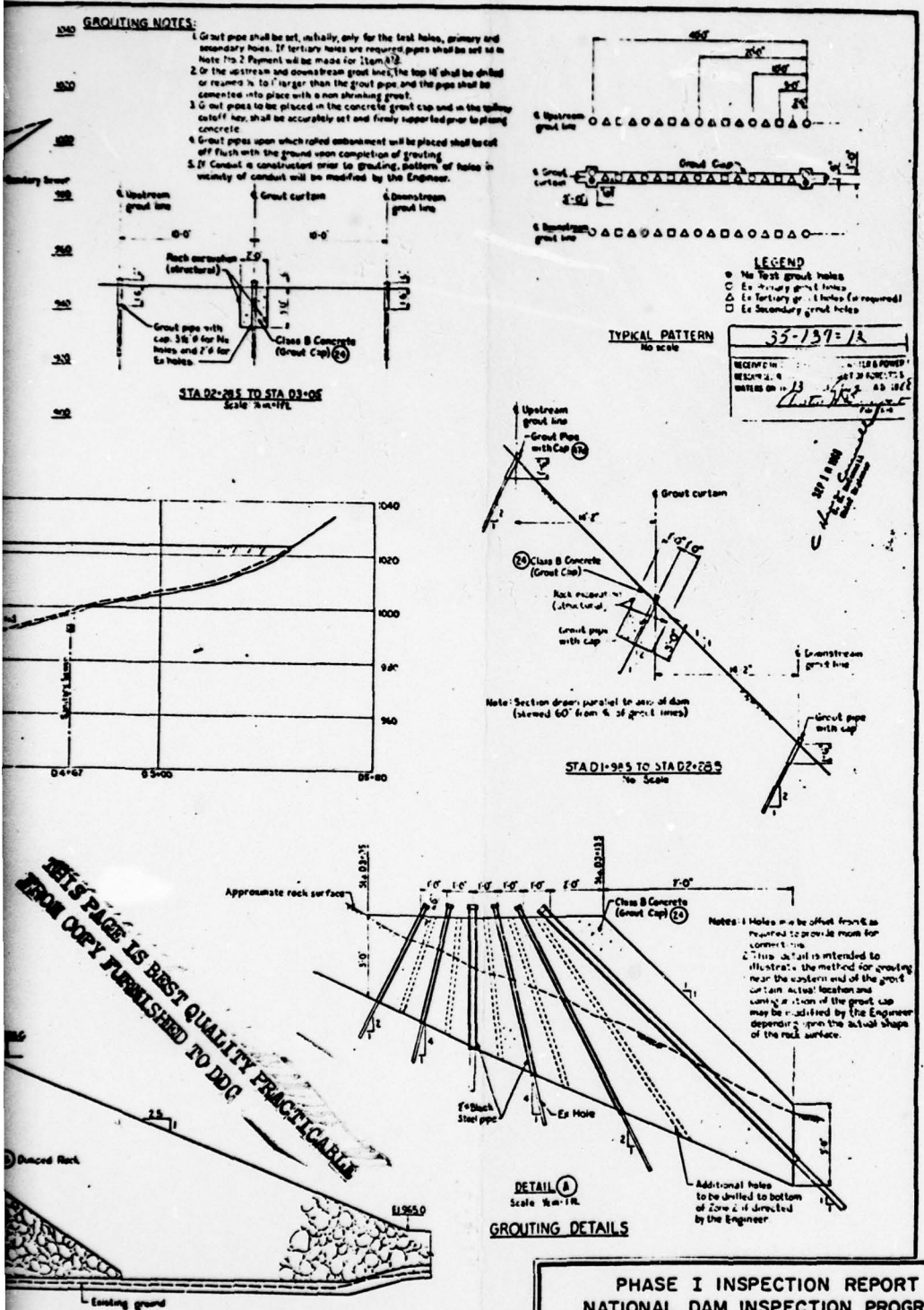
PROFILE OF GROUT CURTAIN AND CUTOFF TRENCH
Scale: 1in. = 20 ft



PROFILE ALONG CENTER LINE OF DAM
Scale: 1in. = 20 ft.



TYPICAL SECTION
(See Dwg No 113 for exceptions)
Scale: 1in. = 10ft.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

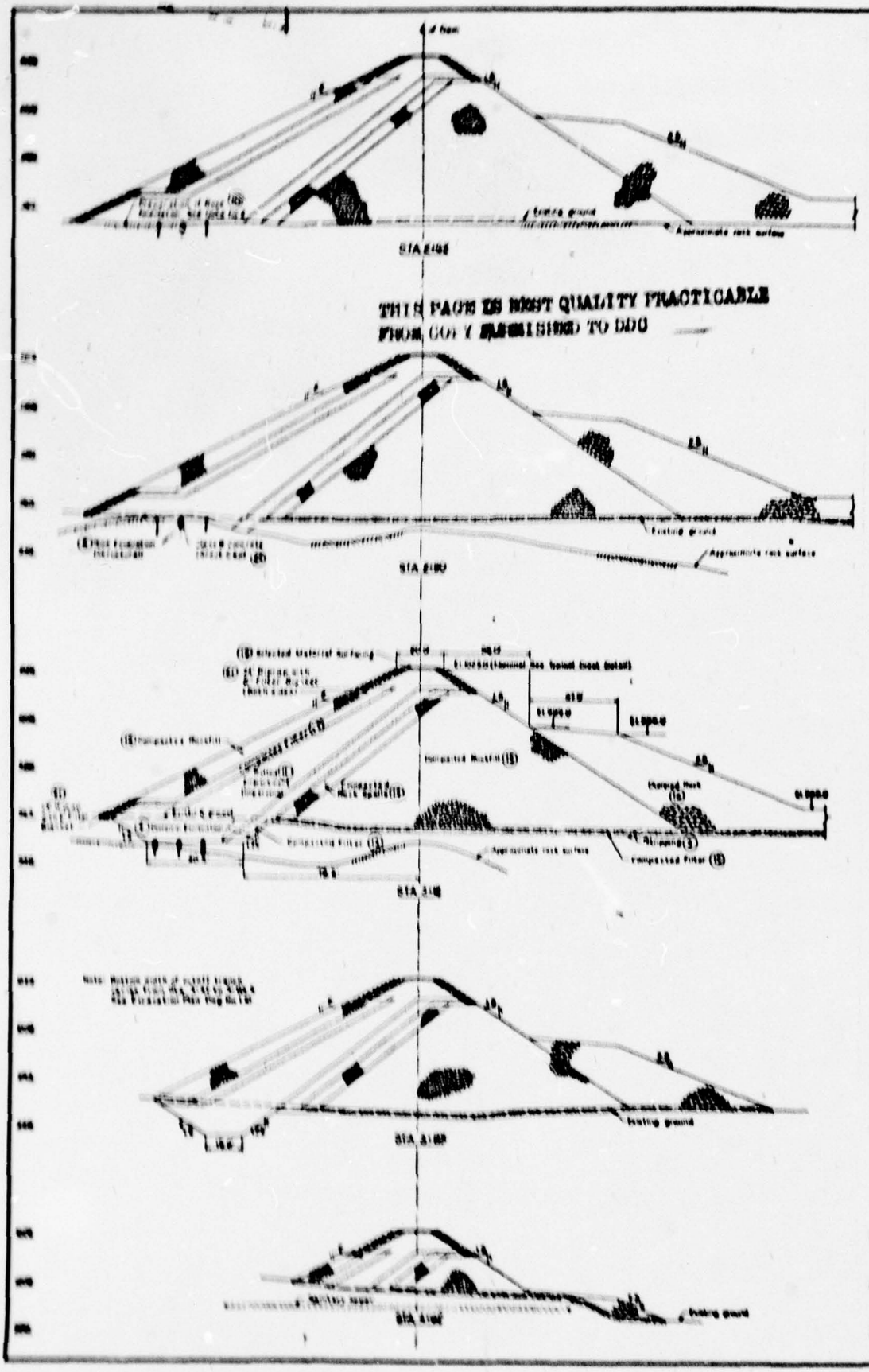
LACKAWANNA DAM

COMMONWEALTH OF PENNYSLVANIA

EMBANKMENT PROFILE AND GROUTING DETAILS

SEPTEMBER 1978 PLATE 3

2



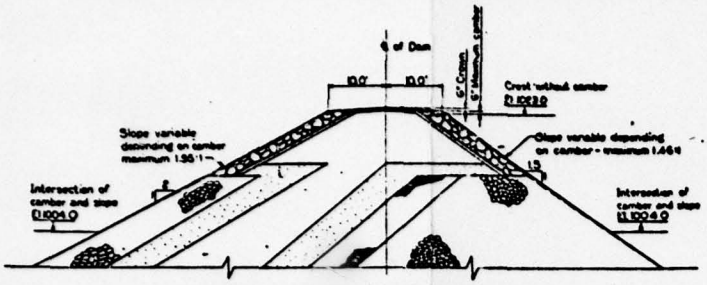
MATERIAL GRADATION REQUIREMENTS

Material	Sieve Size	% Passing By Weight
Compacted Filter		
Compacted Rock Spall		
Compacted Backfill		
Dumped Rock Spall	No more than 50% by weight shall be less than	

* Maximum size shall be such that it can be incorporated into the work site

REFERENCES
1. Elevation - Plan
2. Embankment - Typical Cross Section

NOTES:
1. Sections are shown looking in the direction of increasing stations.
2. Rock surfaces against which impervious embankment will be placed shall be prepared as described in the specifications.



TYPICAL CREST DETAIL
Scale: 1in = 6ft

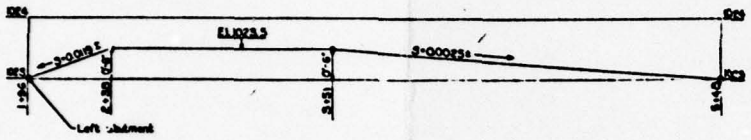
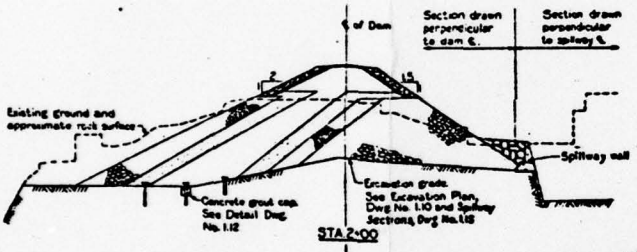
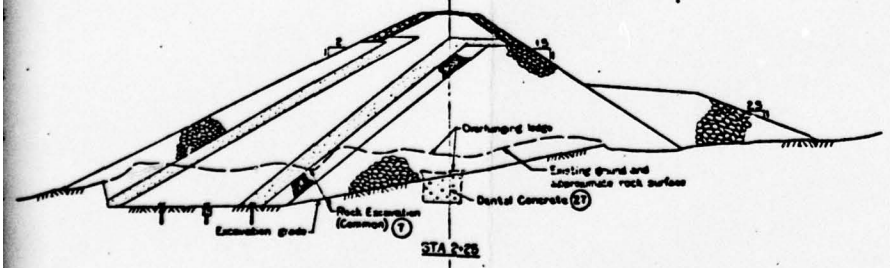


DIAGRAM FOR CAMBER ON CREST OF DAM
Scale: Horizontal 1in = 30ft
Vertical 1in = 1ft





CROSS SECTIONS
Scale: 1in = 20ft.

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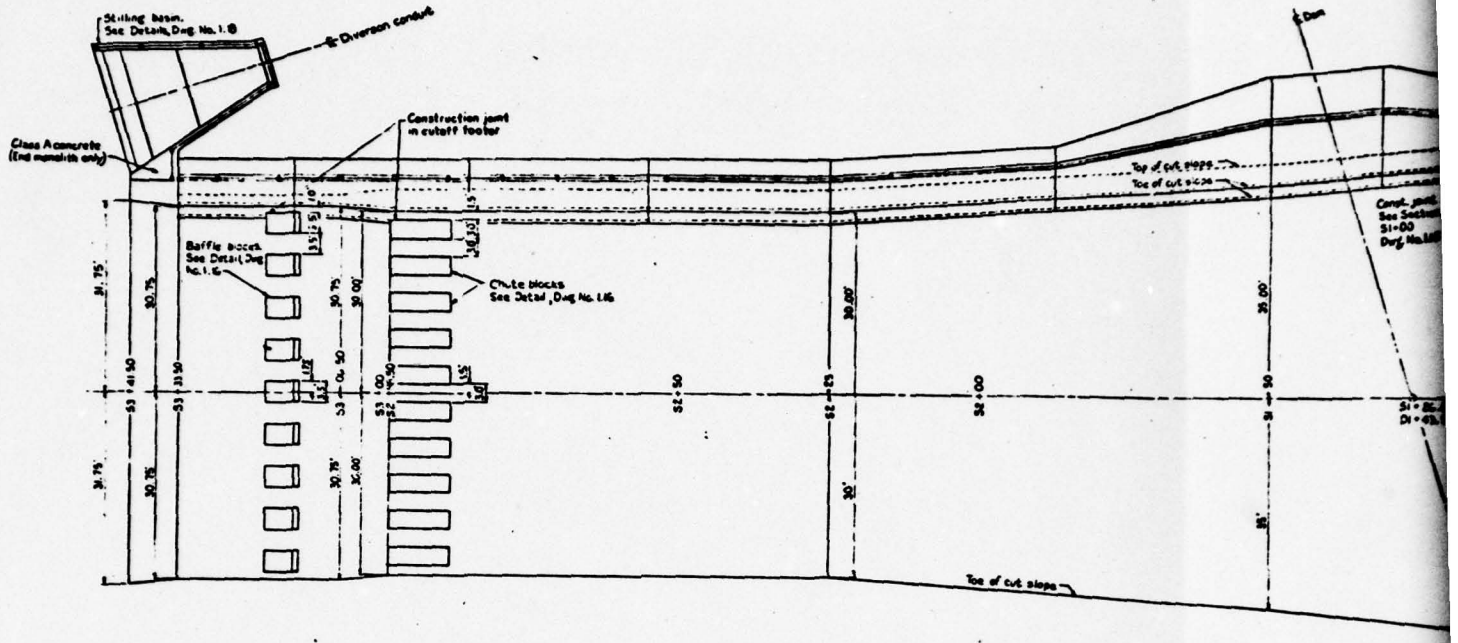
NATIONAL DAM INSPECTION PROGRAM

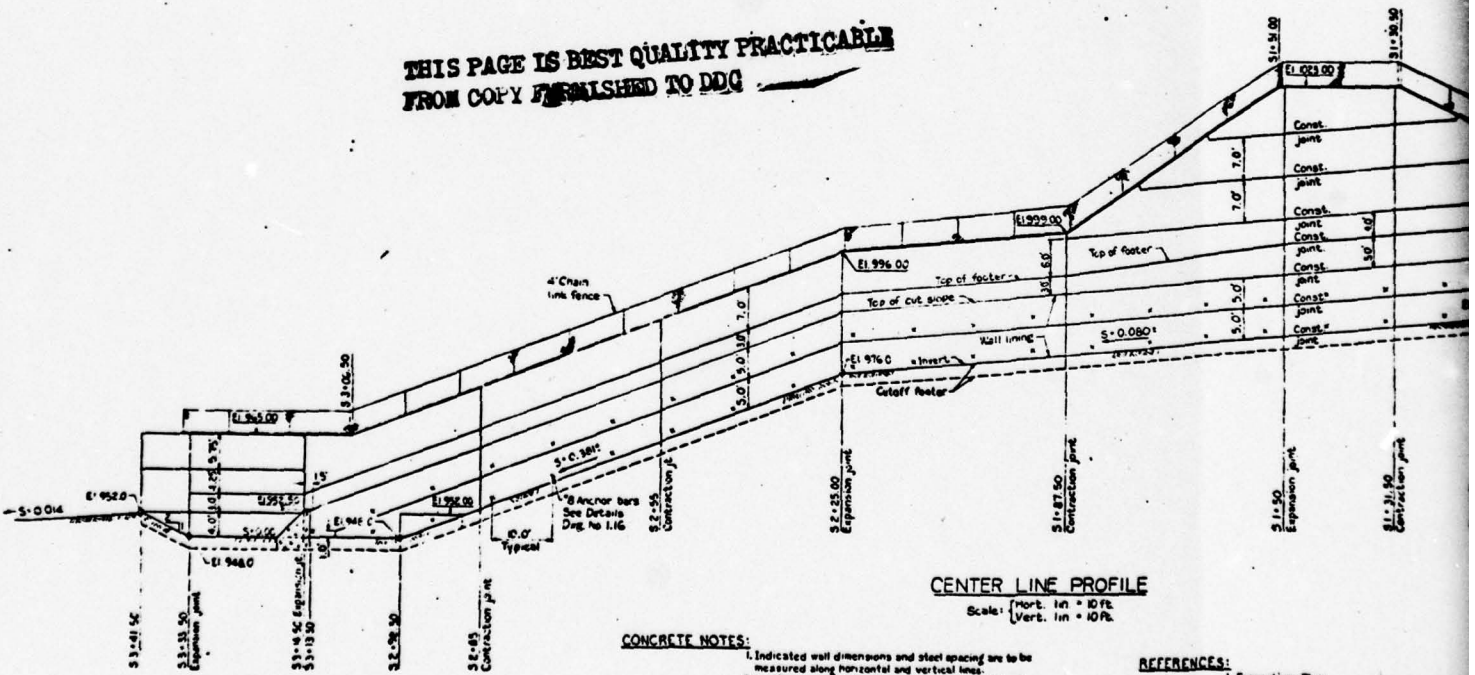
LACKAWANNA DAM
COMMONWEALTH OF PENNYSLVANIA

EMBANKMENT SECTIONS

SEPTEMBER 1978 PLATE 4



PLAN
Scale: 1 in. = 10 ft.



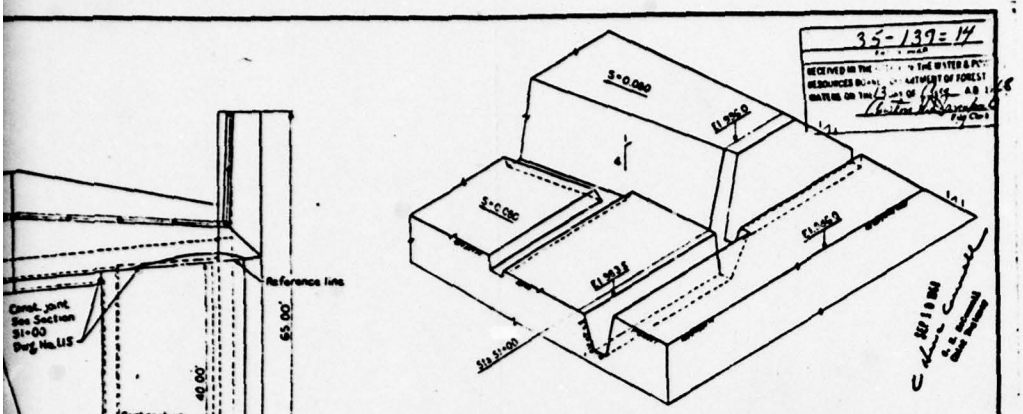
CENTER LINE PROFILE
Scale: Hort. 1in = 10 ft.
Vert. 1in = 10 ft.

CONCRETE NOTES:

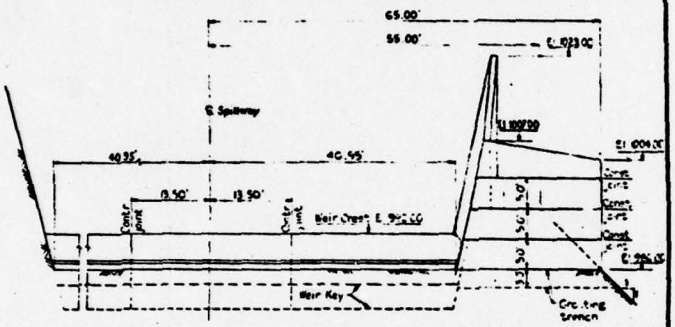
1. Indicated wall dimensions and steel spacing are to be measured along horizontal and vertical lines.
2. Longitudinal steel in walls, shall be placed parallel to the invert, except in the conduit stilling basin.
3. Chamfer all exposed edges and all exposed joints in walls 3/4".
4. All reinforcement shall be placed 2" clear (edge of steel to face of concrete) unless otherwise noted.
5. All splices in the reinforcement are not necessarily shown. Location of splices shall be determined by the contractor in accordance with the Specifications, subject to approval by the Engineer.
6. Minimum splice length shall be 30 diameters of the largest bar in the splice.
7. (N) indicates concrete finish in accordance with the Specifications.
8. Steel reinforcement shall be paid for under item (13).

REFERENCES:

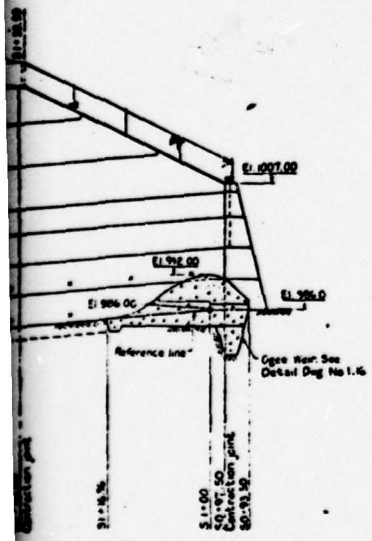
1. Excavation-Plan
2. Spillway-Cross Sections
3. Spillway-Structural Details
4. Diversion Conduit-Stilling Basin

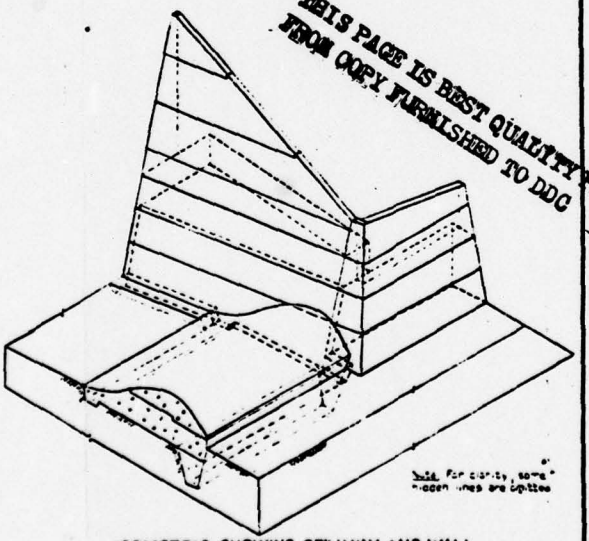


ISOMETRIC SHOWING SPILLWAY AND WALL EXCAVATION



FRONT VIEW
(Looking downstream)





Note: For clarity, some hidden lines are omitted

ISOMETRIC SHOWING SPILLWAY AND WALL

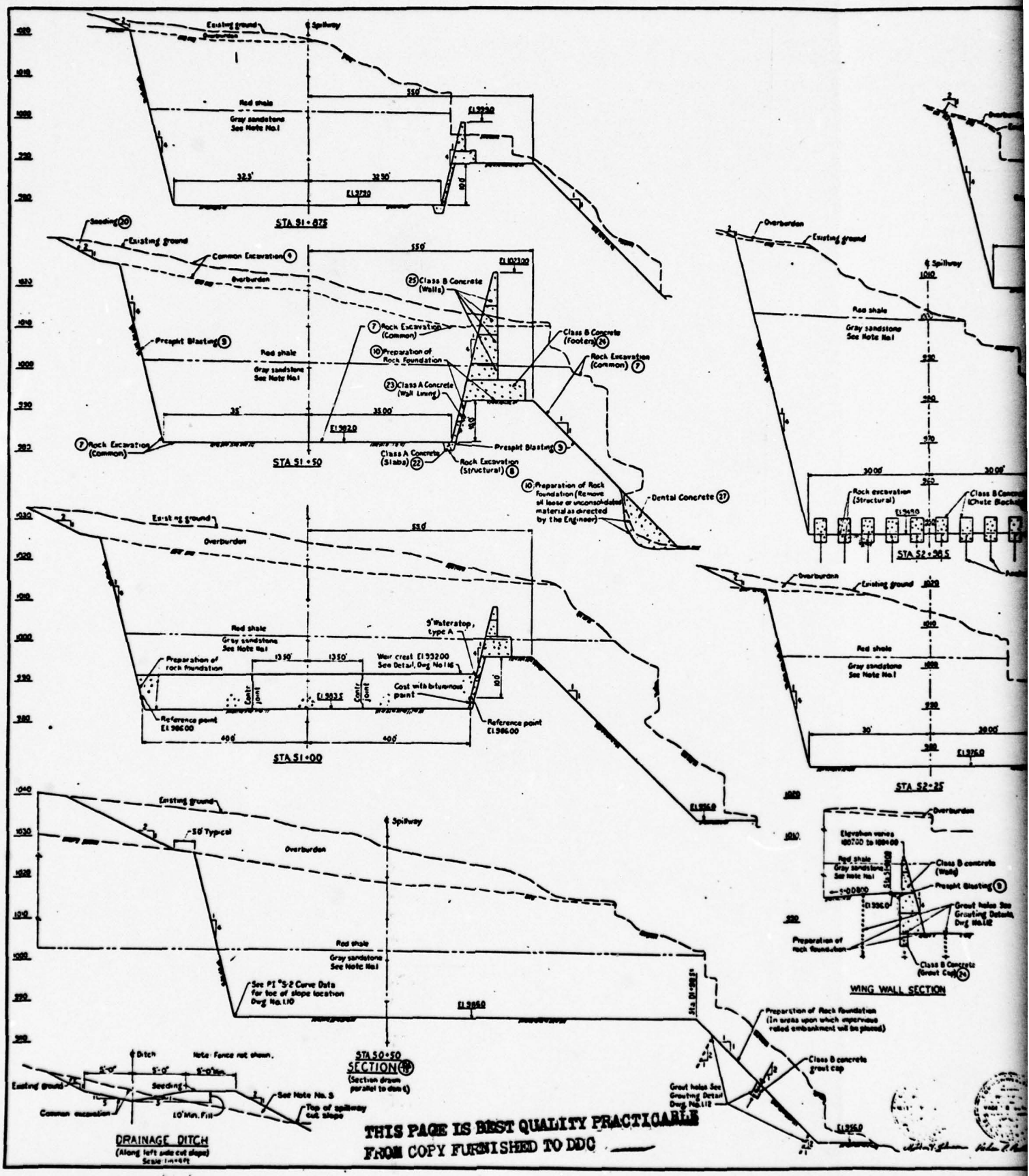
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

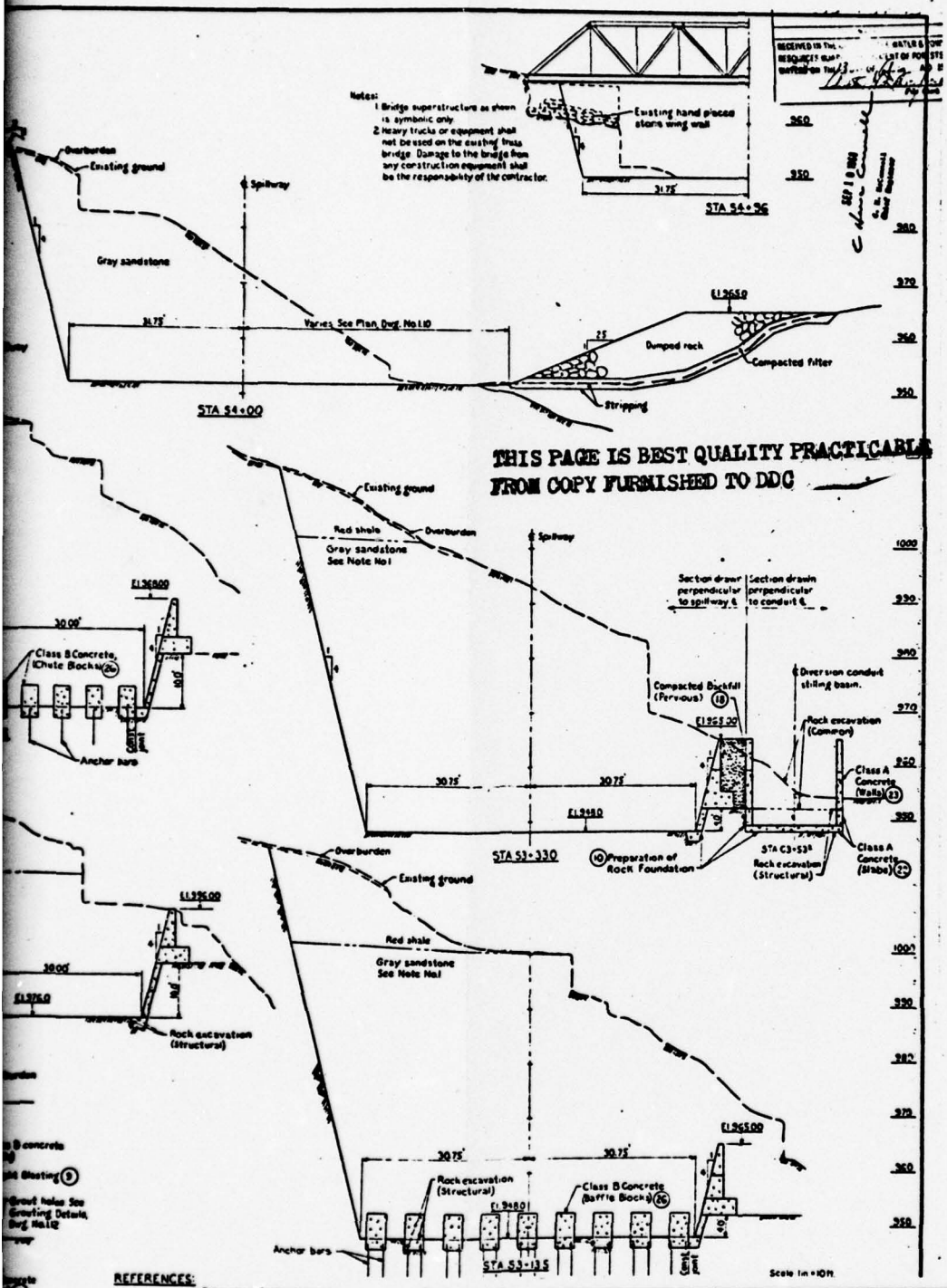
LACKAWANNA DAM

COMMONWEALTH OF PENNYSLVANIA

SPILLWAY
PLAN AND PROFILE

SEPTEMBER 1978 PLATE 5





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REFERENCES:
1. Subsurface Exploration Logs ..... Dwg Nos. 14 thru 19
2. Excavation - Plan ..... Dwg No. 110
3. Spillway - Plan and Profile ..... Dwg No. 111
4. Spillway - Structural Details ..... Dwg No. 115

NOTES:
1. The dividing line between red shale and gray sandstone as shown is approximate and is intended only to indicate the availability of material for constructing the rockfill portion of the dam. See Boring Logs for more detailed information.
2. Embankment is not shown on these sections.
3. Where overburden is greater than 10' deep, a seeded drainage ditch shall be provided to protect the cut slope from runoff. Attempt should be made to balance cut and fill as indicated. Payment will be made for Common Excavation Item No. (4)

NO.	DATE	REVISION	BY	CHK.	APPR.

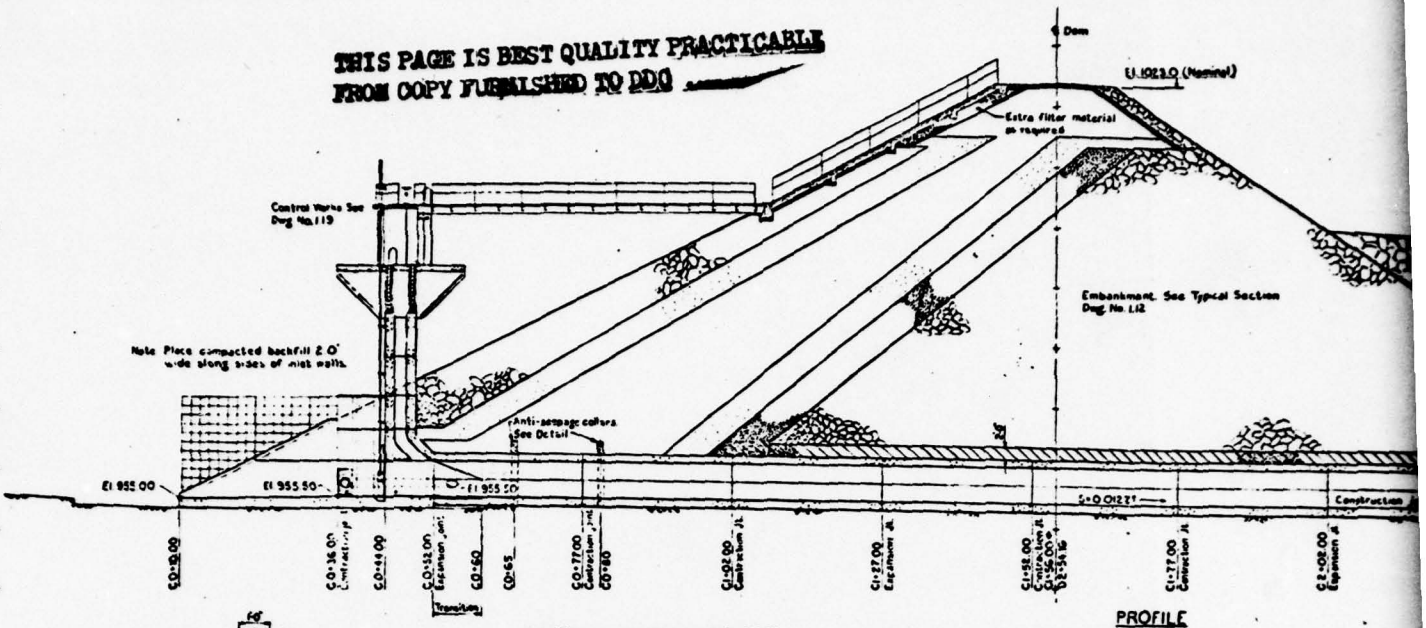
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LACKAWANNA DAM

COMMONWEALTH OF PENNYSLVANIA

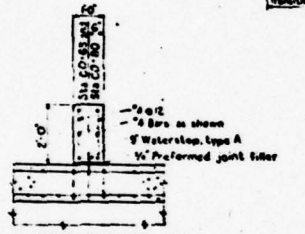
SPILLWAY SECTIONS

SEPTEMBER 1978 PLATE 6

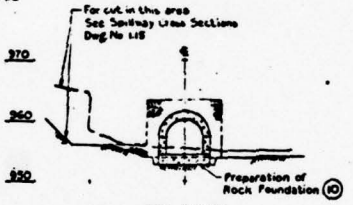


PROFILE
Scale: 1in=10ft

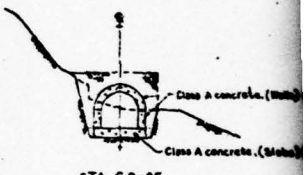
Note: 9" Waterstop, type A in joints at Sta. C0+36, Sta. C0+52, Sta. C0+77 and Sta. C1+02



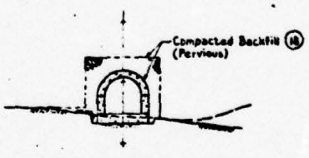
ANTI-SEEPAGE COLLAR
Scale: 1in=1ft



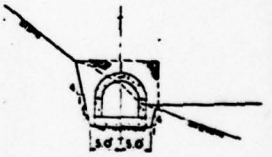
STA. C1+35



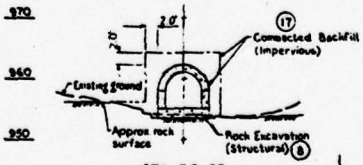
STA. C2+35



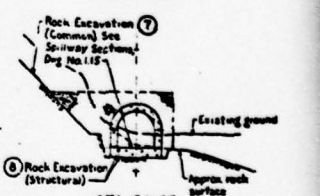
STA. C1+10



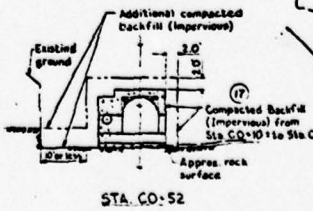
STA. C2+10



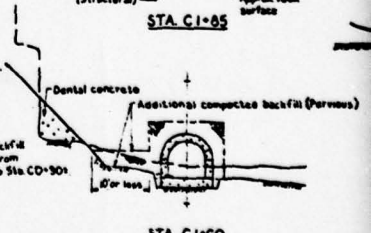
STA. C0+85



STA. C1+85

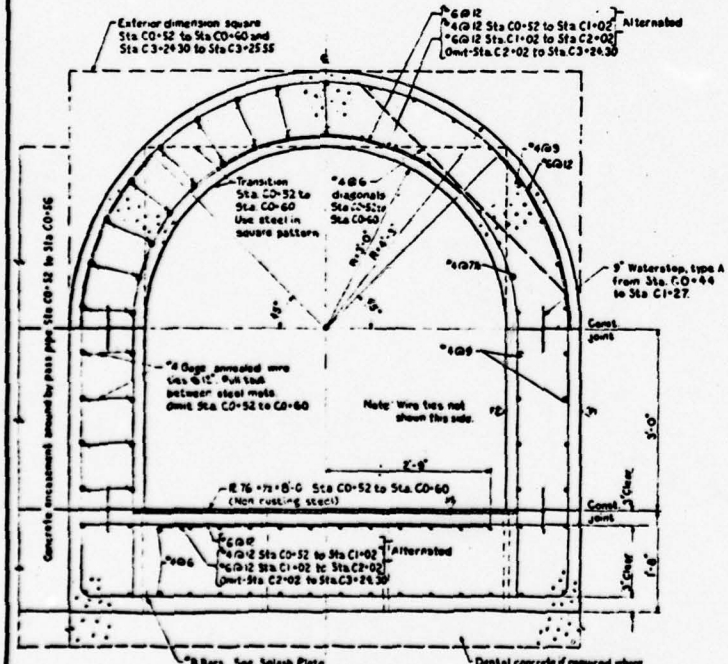


STA. C0+52



STA. C1+60

Note: Dam embankment not shown

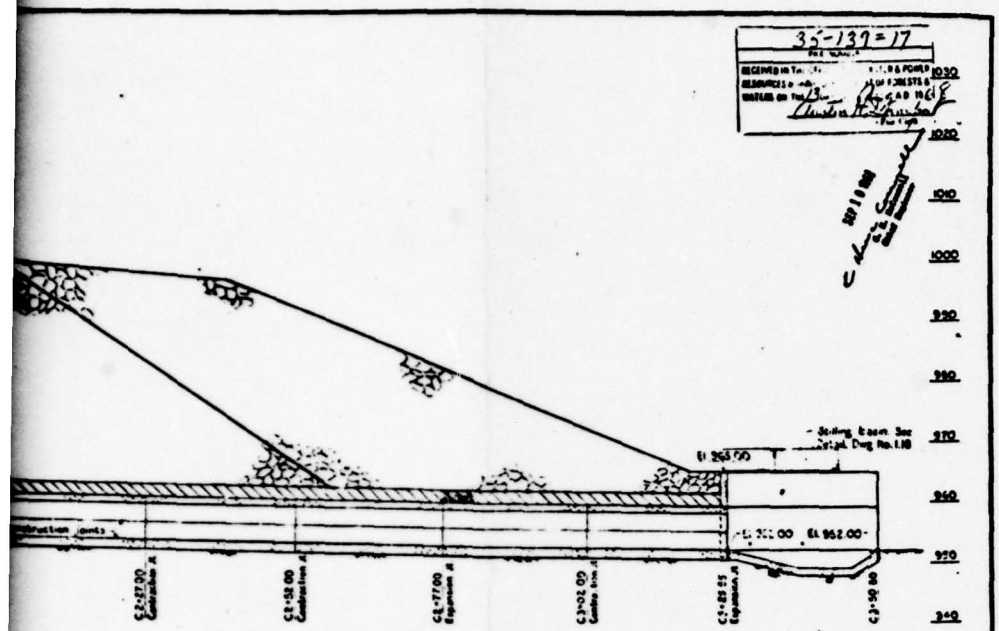


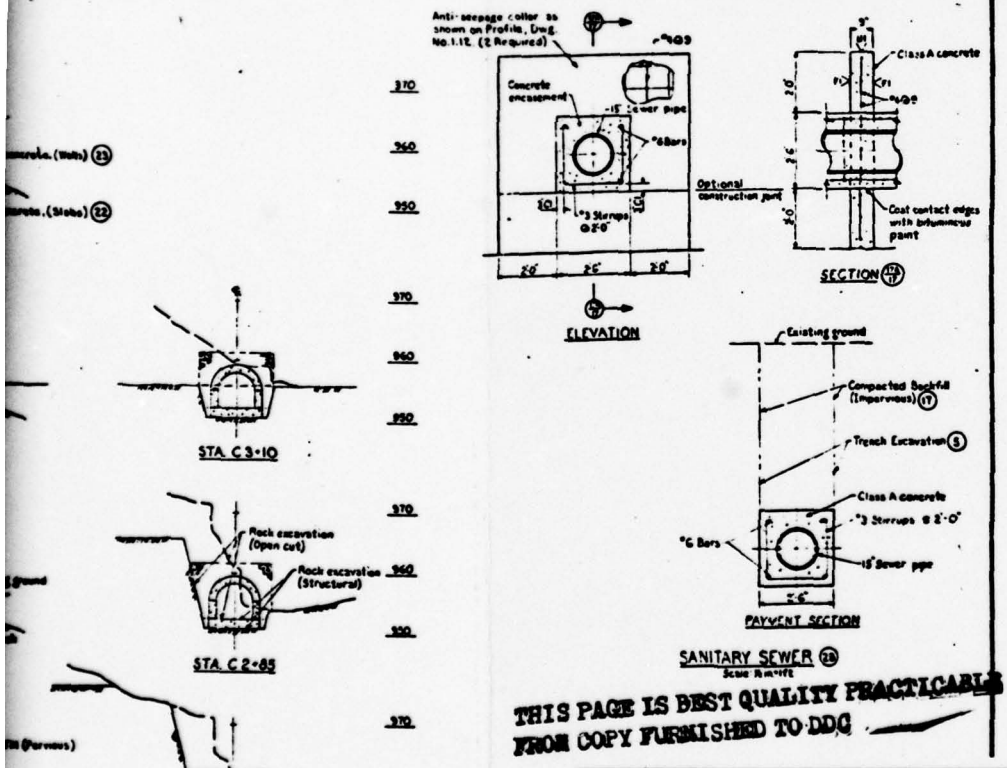
STRUCTURAL DETAILS
STA C0+52.00 TO STA C3+24.30
Scale: 1in=1ft

REFERENCES:
1. Diversion Conduit - Stilling Basin Details ..... Dwg No. I.18
2. Control Works - Structural Details ..... Dwg No. I.19

NOTES:
1. For General Concrete Notes, See Dwg No. I.16.

CROSS SECTIONS
Scale: 1in=10ft





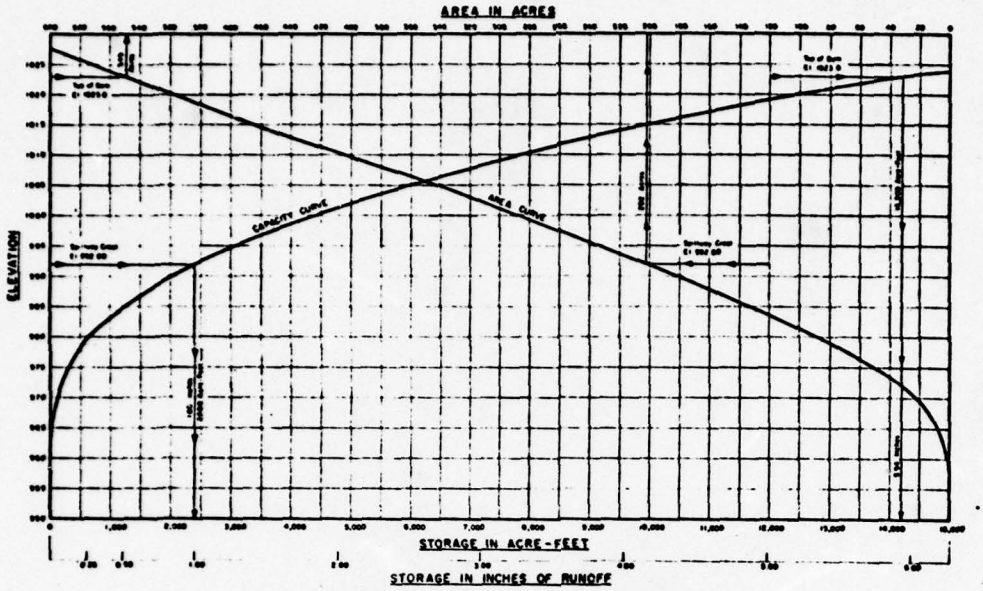
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LACKAWANNA DAM

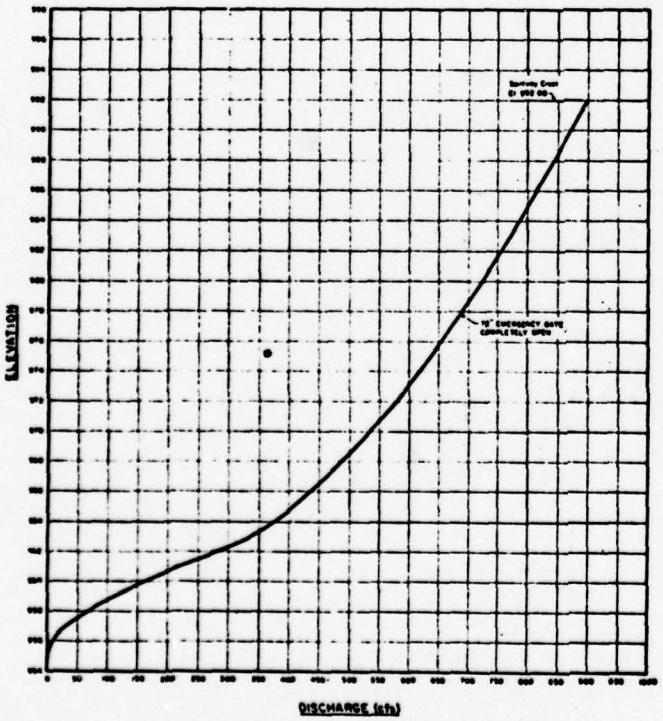
COMMONWEALTH OF PENNYSLVANIA

OUTLET WORKS PROFILE AND DETAILS

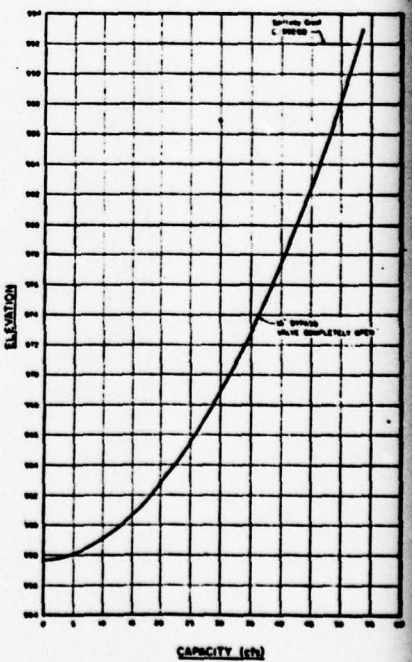
SEPTEMBER 1978 PLATE 7



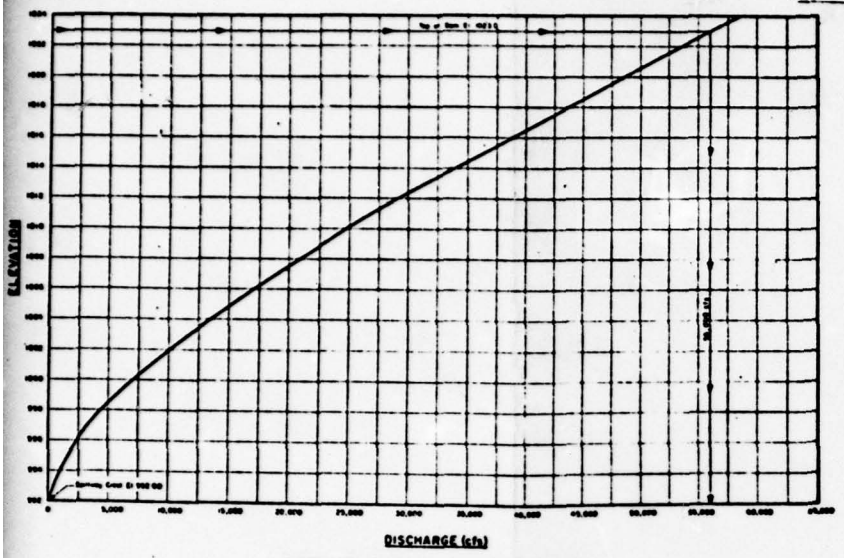
RESERVOIR AREA-CAPACITY CURVES



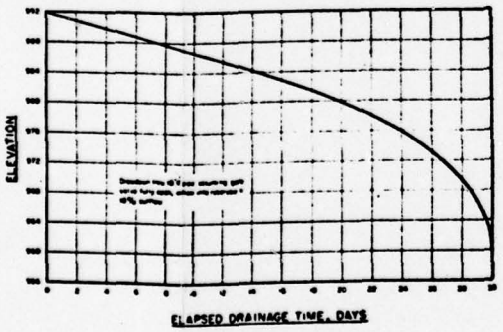
RATING CURVE FOR DIVERSION CONDUIT



RATING CURVE FOR BY-PASS CONDUIT



RATING CURVE FOR SPILLWAY



DRAWDOWN CURVE

CONDUIT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LACKAWANNA DAM

COMMONWEALTH OF PENNYSLVANIA

HYDRAULIC DATA

SEPTEMBER 1978 PLATE 8

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SEPTEMBER 1978

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Lackawanna Dam

NDS ID NO.: PA-00913 DER ID NO.: 35-139

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	Complete set of contract drawings available.
REGIONAL VICINITY MAP	Project is not shown on USGS Maps. When updated, project will be on USGS Quadrangle Sheet Dalton, Pa., N4130-W7537.5/7.5.
CONSTRUCTION HISTORY	Constructed 1969-1971 by Commonwealth of Pennsylvania, Department of Forests and Waters, Bureau of State Parks.
TYPICAL SECTIONS OF DAM	Available.
OUTLETS: Plan Details Constraints Discharge Ratings	Available.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Available.
DESIGN REPORTS	1964: Summary report on alternate sites by Dept. of Forests and Waters, Division of Flood Control. 1968: Permit application report by PennDER. Division of Dams and Encroachments.
GEOLOGY REPORTS	General and site geology in 1964 and 1968 design reports.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	Hydraulic data shown on drawings.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	Available.
POSTCONSTRUCTION SURVEYS OF DAM	None.

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Impervious borrow area downstream from site. Previous borrow area upstream from site.
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	June 1972: 4.1 feet over spillway. June 1973: 3.2 feet over spillway. Sept. 1975: 4.5 feet over spillway (approx.)
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	Available.
SPILLWAY: Plan Sections Details	Available.
OPERATING EQUIPMENT: Plans Details	Available.
PREVIOUS INSPECTIONS Dates Deficiencies	5/72: Bedrock deterioration in spillway (Park Sup.) 12/72: No deficiencies (Park Supt.) 6/73: Spillway erosion (Park Supt.) 8/73: No seepage; some erosion of spillway from Agnes flood; some eroded areas on embankment; brush on downstream slope. (Division of Completed Projects (DCP)). 12/73: Spillway erosion (Park Supt.) 8/74: Small trees and brush on downstream slope; eroded rock in stilling basin; no seepage (DCP). 10/75: Some erosion of spillway bedrock from Eloise flood (DCP). 8/76: Marsh area downstream from dam (DCP).

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Lackawanna Dam NDS ID NO.: PA-00913 DER ID NO.: 35-139

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): Elevation 992.0.

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Elevation 1023.0.

ELEVATION MAXIMUM DESIGN POOL: Elevation 1023.0.

ELEVATION TOP DAM: Elevation 1023.0.

SPILLWAY CREST:
- a. Elevation 992.0.
- b. Type Concrete ogee; chute excavated into rock.
- c. Width Not applicable.
- d. Length 80 feet.
- e. Location Spillover Left abutment.
- f. Number and Type of Gates None.

OUTLET WORKS:
- a. Type Drop inlet structure; 6-foot horseshoe conduit.
- b. Location Center of valley.
- c. Entrance Inverts Intake at El. 986.0; Drops to El. 955.5.
- d. Exit Inverts Elevation 951.7.
- e. Emergency Draindown Facilities Low level intake at drop inlet.

HYDROMETEOROLOGICAL GAGES:
- a. Type None.
- b. Location None.
- c. Records None.

MAXIMUM NONDAMAGING DISCHARGE: Unknown.

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SEPTEMBER 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Lackawanna Dam County: Lackawanna State: Pennsylvania

NDS ID No.: PA-00913 DER ID No.: 35-139

Type of Dam: Rockfill Hazard Category: High

Date(s) Inspection: 14-15 August 1978 Weather: Clear Temperature: 90°F

Pool Elevation at Time of Inspection: 992.1 msl/Tailwater at Time of Inspection: 952.6 msl

Inspection Personnel:

D. Wilson (GFCC)	R. Rahn (PennDER)	
J. Crouse (GFCC)	G. Frost (Park Supt.)	
D. Ebersole (GFCC)	C. Micciche (Park Foreman)	

D. Wilson (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	None.	
CREST ALIGNMENT: Vertical Horizontal	Horizontal: no irregularities. Vertical: elevation varies from El. 1022.2 to El. 1023.3.	Design elevation for top of dam is El. 1023.0. Low area is at spillway wall.
RIPRAP FAILURES	1. Upstream slope: some stone missing at top of dam at spillway; overall in good condition. 2. Downstream slope: growth of weeds over most of slope but no brush.	1. Park Supt. said stone removed by vandals. 2. Brush and weeds are cut twice each year.

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	1. Right abutment: no abnormalities. 2. Spillway: low area and missing riprap.	
ANY NOTICEABLE SEEPAGE	One damp area at downstream toe near right abutment.	No standing water or seepage; vegetation lush; ground not soft.
STAFF GAGE AND RECORDER	Staff gages at right abutment.	
DRAINS	None visible.	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete: good condition. Joint Nos. 4, 6, 7, and 8 (counting from downstream end) leaking on left side in bottom 24 inches of joints.	Each joint leaking less than 1 gpm. Strong odor of hydrogen sulfide.
INTAKE STRUCTURE	Concrete: good condition. Metalwork: all painted. Gate stems: all lubricated. Stop logs: good condition.	Stop logs were in place at time of inspection. Bypass valve (18-inch) was open slightly to augment flow.
OUTLET STRUCTURE	Concrete: good condition.	Strong odor of hydrogen sulfide. Three weep holes on left side all had some clear flow.
OUTLET CHANNEL	No deficiencies.	
EMERGENCY GATE	1. 6-foot gate opened easily to 4 inches. 2. 18-inch bypass opened easily to 4 inches.	1. 6-foot gate has 10:1 gear reducer; recently opened all the way. 2. Bypass valve used to augment streamflow.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Good condition.	
APPROACH CHANNEL	Reservoir; clear, no operation constraints.	Possible cross-flow across embankment at high pool levels. Might damage fencing but probably would not erode embankment.
DISCHARGE CHANNEL	Channel excavated in rock and somewhat irregular. No apparent deficiencies.	Backfill concrete placed by Corps of Engineers for erosion repair after 1972 flood in good condition.
BRIDGE AND PIERS	None.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	Staff gages at right abutment.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Steep near dam; moderate farther upstream. No sign of instability.	
SEDIMENTATION	None reported by Park Superintendent.	
WATERSHED DESCRIPTION	Partially wooded and partially farmland. Partially controlled by PennDER.	

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Iron truss bridge 200 feet downstream from dam. Otherwise, channel is straight and clear.	Bridge situated above top of outlet channel. Probably not a constraint. Would wash away easily.
SLOPES	No erosion.	Riprap in good condition
APPROXIMATE NUMBER OF HOMES AND POPULATION	Community of Factoryville.	

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

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SEPTEMBER 1978

APPENDIX C

HYDROLOGY AND HYDRAULICS

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT LACKAWANNA DAM (35-139) FILE NO. 7613.5B
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 1 OF 2 SHEETS
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY JMC DATE 8/21/78 CHECKED BY GJW DATE 9/12/78

CLASSIFICATION

HIGH HAZARD, SINCE DOWNSTREAM POPULATION IS SUBSTANTIAL, AND FAILURE OF THE DAM COULD RESULT IN MORE THAN A FEW LIVES LOST AND EXCESSIVE ECONOMIC LOSS

INTERMEDIATE SIZE, SINCE HEIGHT = 69 FEET AND CAPACITY = 14,200 AC-FT
REFERENCE: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS," p. D-8

SPILLWAY DESIGN FLOOD (SDF)

THE SDF SHOULD BE THE PMF (FROM p. D-12 OF "REC. GUIDELINES ...")

HYDROLOGY AND HYDRAULICS ANALYSIS

REFERENCE: PHASE I PROCEDURE PACKAGE

II A. 2. PMF INFLOW HYDROGRAPH NOT AVAILABLE

a. BALTIMORE CONTACT RECOMMENDS TRANSPOSING A PMF PEAK FROM STILLWATER RESERVOIR, WHERE THE DRAINAGE AREA = 36.8 SQ. MI. AND THE PMF PEAK INFLOW = 39,500 CFS. THE TRANSPOSITION IS TO A POWER OF 0.8., SO

$$\frac{Q_1}{Q_2} = \left(\frac{D.A._1}{D.A._2}\right)^{0.8}$$

AND, $$Q_1 = \left(\frac{D.A._1}{D.A._2}\right)^{0.8} Q_2$$

PMF PEAK INFLOW FOR LACKAWANNA DAM = $Q_1 = \left(\frac{44.9}{36.8}\right)^{0.8} (39,500)$

PMF PEAK INFLOW = 46,314, SAY 46,310 CFS

EFFECT OF UPSTREAM RESERVOIRS

SOME LAKES AND PONDS EXIST UPSTREAM OF LACKAWANNA RESERVOIR. HOWEVER, THE EFFECTS OF THE RELATIVELY SMALL AMOUNT OF SURCHARGE STORAGE WOULD BE MINIMAL. ALSO, IT APPEARS THAT THE SPILLWAY CAPACITY WILL BE ADEQUATE AS IS, AND ANY SURCHARGE STORAGE EFFECT UPSTREAM WOULD PROBABLY INCREASE THE PERCENTAGE OF THE PMF THAT LACKAWANNA DAM COULD PASS. THEREFORE, IT IS CONSERVATIVE TO ASSUME THAT THERE IS NO EFFECT FROM ANY UPSTREAM BODY OF WATER.

B. ABILITY OF SPILLWAY TO PASS THE PMF

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT LACKAWANNA DAM (35-139) FILE NO. 7613.5B
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 2 OF 2 SHEET
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY VRK DATE 5/21/18 CHECKED BY RJW DATE 9/12/18

1. CAPACITY OF SPILLWAY - REFERENCE : DRAWING NO. R35:1-3, TUNKHANNOCK DAM PLANS, DER FILES

ASSUME THAT GATED WORK DOES NOT PASS ANY FLOW SINCE THE OPERATION AND MAINTENANCE MANUAL SPECIFIES GATES TO BE CLOSED AND STOPLOGS TO BE IN PLACE DURING FLOOD.

DESIGN TOP OF DAM ELEV. = 1023 ; SPILLWAY DISCHARGE = 56,000 CFS
ACTUAL TOP OF DAM ELEV. = 1022.2 ; SPILLWAY DISCHARGE = 54,000 CFS

2. IN EITHER CASE, THE PMF PEAK FLOW IS LESS THAN THE TOTAL CAPACITY (46,310 < 54,000)
   a. NO SPILLWAY FOOTING FOR THE PMF IS NECESSARY
   b. THE DAM CAN BE ASSUMED TO BE ABLE TO PASS THE PMF WITHOUT OVERTOPPING

PERCENT OF PMF THAT SPILLWAY CAN PASS
WITHOUT SURCHARGE STORAGE EFFECT

$$\% \text{ OF PMF} = \frac{Q_{CAPACITY}}{Q_{PMF}} \times 100\%$$

$$= \frac{56,000}{46,310} \times 100\%$$

$$= 121\% \quad \text{(DESIGN)}$$

$$\% \text{ OF PMF} = \frac{54,000}{46,310} \times 100\%$$

$$= 117\% \quad \text{(ACTUAL)}$$

SP 11660A

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

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SEPTEMBER 1978

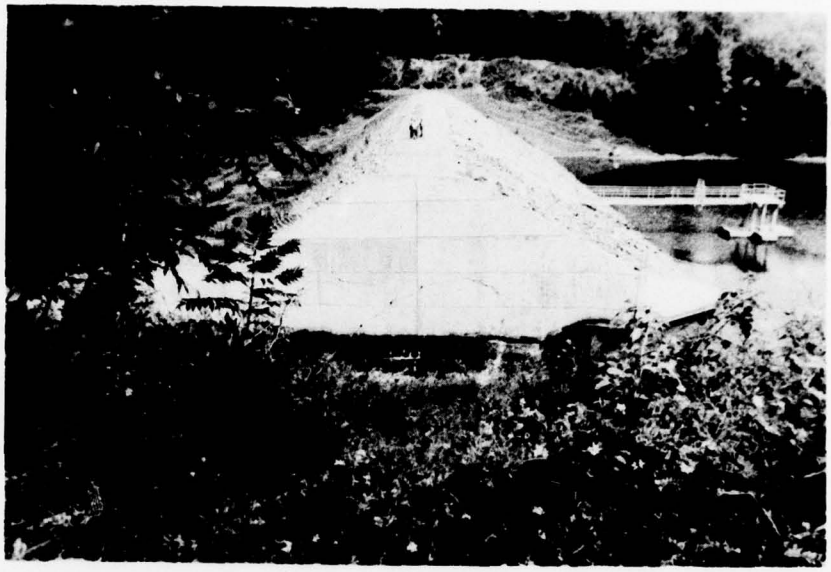
APPENDIX D

PHOTOGRAPHS

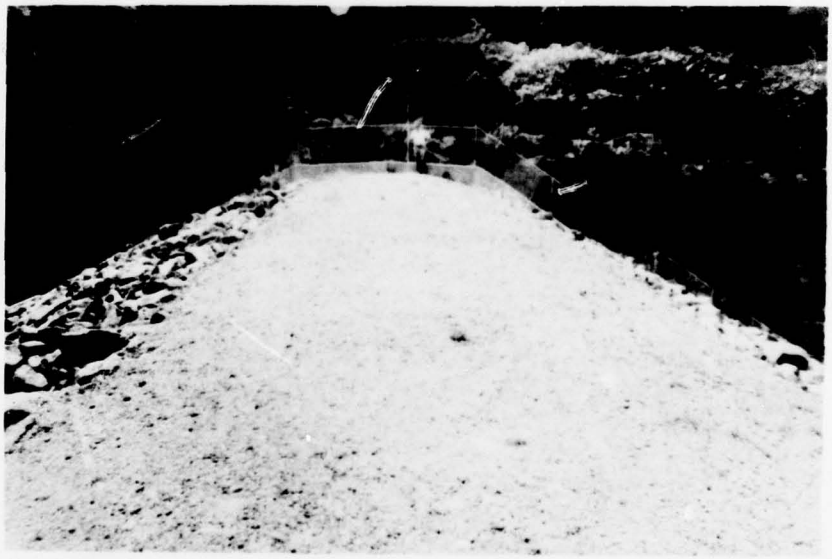
LACKAWANNA DAM

A. Embankment.
View from Upstream.

B. Embankment.
View from Right Hillside.



C. Spillway and Embankment.
View from Left Hillside.

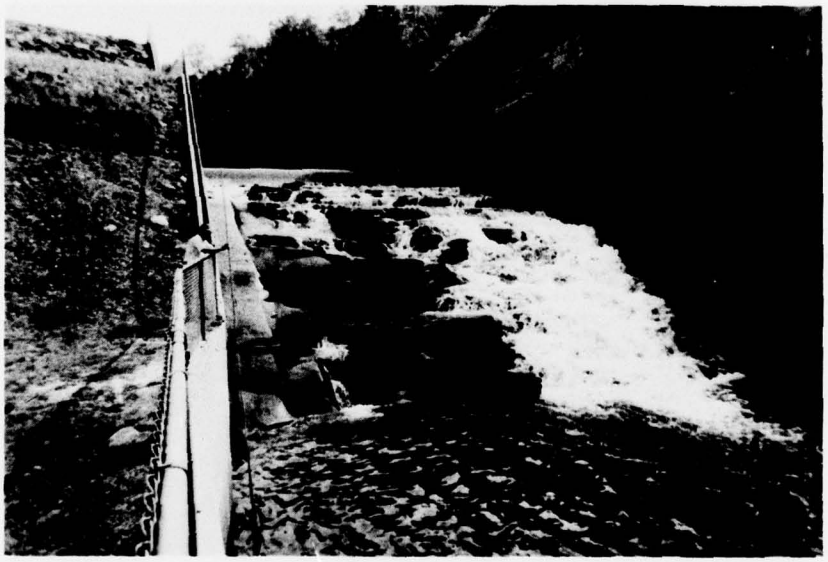


D. Low Area at Spillway Training Wall.

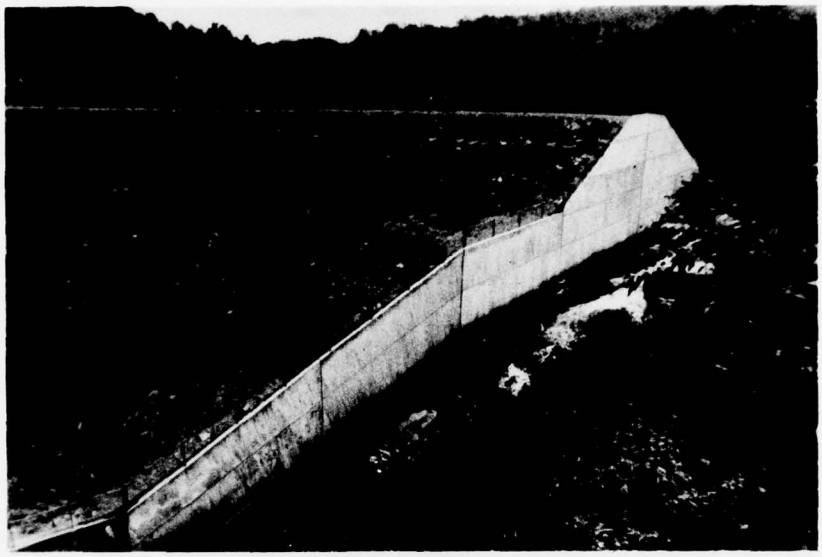
E. Downstream Slopes of Embankment.
View from Right Abutment.

F. Spillway Approach Channel.

G. Concrete Spillway Weir.

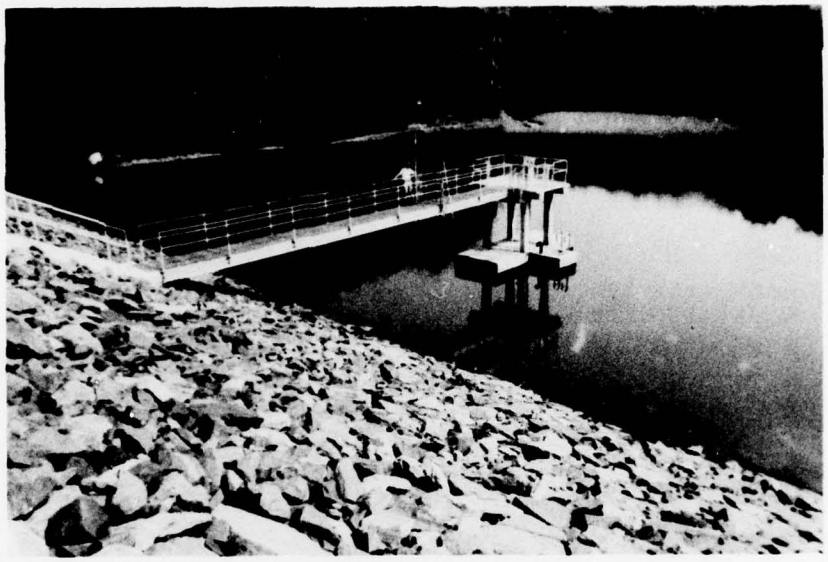


H. Spillway Outlet Channel and Stilling Basin.

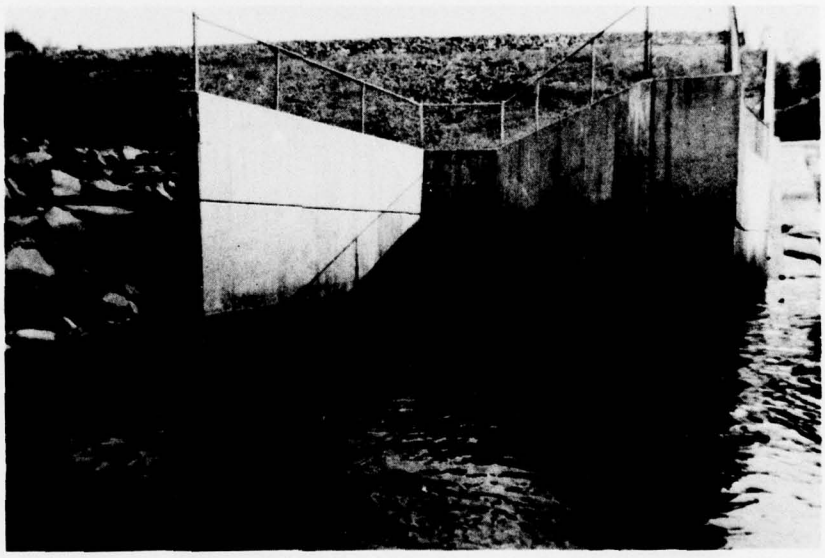


J. Embankment and Spillway Outlet Channel.
View from Left Hillside.

K. Downstream Channel.



L. Intake Structure.



M. Outlet Structure.

SUSQUEHANNA RIVER BASIN

SOUTH BRANCH TUNKHANNOCK CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

LACKAWANNA DAM

NDS ID No. PA-00913
DER ID No. 35-139

COMMONWEALTH OF PENNSYLVANIA

PHASE I INSPECTION REPORT

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APPENDIX E

GEOLOGY

LACKAWANNA DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35° - 40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. Northwest of Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country to the northwest. Consequently, most of

the drainage in this part of the County flow westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. The dam and reservoir are sited in nearly horizontally stratified gray sandy shale and green sandstone of the Catskill continental group northwest of the Lackawanna River and the Lackawanna Syncline. The streamflow from the area is westward to the Susquehanna River by way of Tunkhannock Creek. The nearly horizontally stratified rock is exposed in the streambed and portions of the left bank. The bedrock in the right bank is covered by a deep deposit of glacial till. It appears that the stream was originally located in a pre-glacial valley some 100 feet below the present streambed. The action of the glacier filled the old valley, raising the invert of the stream and forcing the water against the rock of the left abutment. Subsequent erosion of the glacial deposits, and bed base rock, left the stream perched on a shelf of rock from 50 to 100 feet wide, which forms the present streambed.